

American Printing House for the Blind

Annual Report
Research and Development
1959-1969

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ANNUAL REPORT: DEPARTMENT OF EDUCATIONAL RESEARCH MAR 21 1972

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INTRODUCTION:

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AMERICAN PRINTING HOUSE FOR THE BLIND
LOUISVILLE, KENTUCKY

Research this year has been concentrated in two general areas: Problems basic to Braille reading readiness and problems related to production of materials by the American Printing House. This dichotomy of research interest appears to be a very practical one. It allows research on basic educational problems to procede at a rate most appropriate for the present state of the art, and, at the same time, provides opportunity to investigate subjects that have practical significance for current production problems.

Although this report will emphasize research completed during the past year and that planned for next year, this does not imply that activity was restricted solely to these items. Work was continued on the accumulation of a complete research bibliography for the field. This effort is still far from completion, and progress is occurring at a slower rate than at the time of last year's report. Speaking engagements and participation in professional meetings have also taken up a significant amount of time during the year.

RESEARCH CONDUCTED DURING THE YEAR ENDING 30 JUNE 1959

1. Stanford Achievement Arithmetic Computation Tests:

A new Braille Adaptation of Form J of the Arithmetic Computation Tests was tried out this year. Appropriate tests were administered to 77 third grade children, 70 fourth grade children, 57 sixth grade children, and 78 eighth children. Results indicated that the adaptation was adequate and that the tests had sufficient reliability. They will henceforth be included in our Braille test batteries.

Blind children as a group received scores 16% below the test standards for sighted groups, and analysis of the data revealed significant differences among schools in arithmetic achievement. These differences are somewhat stable throughout the grades although rates of progress among the schools in arithmetic appeared unequal. For example, achievement of some sixth grades surpassed that of some eighth grades. School differences and heterogeneity in progress are believed to be indicative of need for research in methods of teaching arithmetic to blind children.

2. Three studies were conducted which were part of the reading readiness research program described in last year's report.

a. Research on Word Associations:

A previous study reported that blind children tended to use words unrealistically. This was inferred by examining responses of blind children to 39 stimulus words. Excessive dependence on visual terminology was held to result in the formation of loose and invalid concepts. Responsibility for this situation was laid at the feet of educators of the blind.

Since learning to read requires the association of concepts with printed symbols, the quality of the concepts formed by young blind children could have

serious implications for such learning. Therefore, verification of the previous results seemed important. This was achieved by repeating the previous experiment using 55 congenitally blind children from two residential schools. One change was made in that part of this group responded with free rather than controlled association.

Children in the present study gave only 17% visual responses to the stimulus words. This was a statistically significant lesser amount than for the previous study. Responses for 1000 sighted children were available for four of the stimulus words. Responses of blind children in the present study were quite similar to these. It was concluded that excessive use of visual concepts was not a problem for the children studied.

b. Roughness Discrimination Among Children in the Primary Grades:

The purpose of this study was to determine if differences in ability to discriminate surface roughness exists among children in the age groups found in kindergarten through the primary grades. If so, a measure of roughness discrimination might be used as a predictor of ability to learn to read Braille.

The test used required children to pick out the rougher of two small pieces of sandpaper mounted on a card. Fourteen grades of sandpaper were combined in order to give 27 different comparisons. Sixty-three children in grades kindergarten through four and ages 6-13 years were utilized as subjects in the study.

No relationship was found between ability to discriminate roughness and chronological age. However, significant differences were found among grades for this ability. Finer discriminations were significantly easier for children in the upper grades. It was concluded that further work on this problem would be fruitful.

c. Development of a Test of Small Form Perception:

This study resulted in our only complete failure of the year. An attempt

was made to develop a test of form perception which could be used to predict reading readiness. Briefly, the test required children to rapidly discriminate five small solids in a variety of sequences. It was found that test scores were almost completely dependent upon the intelligence of the subject and that the task was too difficult for children in kindergarten and the first grade. Further work in this area is contemplated.

3. Study of Type Characteristics:

Periodically, questions are raised concerning the best type for use in production of large type textbooks. One such question concerns the relative superiority of 18 and 24 point type. Another deals with the type face itself. That is, what style of type is most legible? This study was designed to investigate aspects of both problems simultaneously.

In addition to comparing 18 with 24 point type, the study compared a common school book type (Antique with Old Style) with an experimental type. The experimental type was a sans-serif type with two special characteristics: (a) If the width of the limb of a lower case letter is taken as a unit, most letters will be found to be 4 units wide and 5 units high and (b) spacing between letters is two units. Reading speed was the index used to judge the differences between the variables.

Two-hundred-sixty-four large type readers (ages 8-20 years, grades 4-12) from public and residential schools in Ohio, Illinois, and Kentucky participated in the study. One-half of this group was legally blind. For our purposes these children were randomly assigned to one of eight groups. A legally blind and non-legally blind group read each of four type combinations: 18 point school book type, 18 point experimental type, 24 point school book type, and 24 point experimental type. The reading speed test was an adaptation of the Gates Basic Reading Test, Grades 3-8, 1942 edition. The data were cast in a treatments x treatments x

levels design. Analysis of covariance was applied in order to statistically control differences in reading comprehension among the groups.

Both legally blind and non-legally blind children read 18 point type as fast as they read 24 point type. The common school book type was read significantly faster than the experimental type. Legally blind children read large type at the rate of 91 words per minute and non-legally blind at the rate of 106 words per minute.

4. Reproduction of Pictures for Large Type Books:

A recurring problem in the production of large type textbooks is that of picture legibility. This is primarily the result of attempts to reproduce colored pictures in black and white through the photo-offset process. Such results range from pictures where clearness of contour and distinctiveness of figure-ground relationships are slightly diminished to those where the whole picture appears one area of almost equally dark grays. The goal of this study was to find an inexpensive means of legibly reproducing a picture which would retain many of the aesthetic qualities of the original illustration. Tracing the original seemed to be a feasible means of reaching this goal.

Four types of tracings, each emphasizing cues for form perception, were compared with each other and a photo-offset reproduction using the method of pair-comparison. This process was repeated for each of five pictures. The types of tracings were: (a) A simple line drawing, (b) a line drawing with areas blacked in for contrast, (c) a line drawing with blacked in areas and light shading and (d) a line drawing with blacked in areas and heavy shading. Forty children (ages 11-20 years, grades 5-10, 70% of the group legally blind) who were large type readers at two residential schools were employed as subjects. Results showed that children chose the line drawing with blacked in areas for contrast as more legible than any other picture 75% of the time. All tracings were judged more legible than the photo-offset reproduction for all five pictures.

RESEARCH COMPLETED THIS YEAR

Braille Map Requirements: A Survey of Braille Map Needs and Problems in Their Fulfillment.

Maps depicted in 49 Braille texts on the subjects of history, geography and social studies were tabulated according to geographical area and type of information represented. Identified were 1,765 maps of 74 geographical areas which could be classified according to 16 different categories of information. Greatest need was identified as that for maps of the United States and areas in the Western Hemisphere.

The problems of tactual map symbolism and map size -- map scale were discussed. Vacuum formed plastics were suggested as a medium of increasing the range of varieties and types of maps available.

RESEARCH PLANNED FOR THIS YEAR

1. Studies Falling under the Braille Reading Research Program.

a. Roughness Discrimination Among Children in the Primary Grades:

Additional data will be gathered using the test in its present form. If present findings hold, the test will be revised in an effort to increase reliability. The revised test will then be validated against a reading criterion to determine its effectiveness as a predictor of ability to learn to read Braille.

b. A Pilot Study of the Appropriateness of Vocabularies of Primary Reading Texts for Blind Children:

Using an arbitrary set of criteria, words in primary readers were classified as relating to concepts that were abstract or concrete for beginning Braille readers. Such words as "spoon" were classified as dealing with concrete concepts since this word stood for an object which could be directly experienced by blind children. A word like "star" was classified as dealing with an abstract concept, since this object is not within the direct experience of blind children. Approximately 18% of the words included in the vocabularies of primary reading texts fell in the abstract category. Inclusion of abstract or ambiguous concepts in beginning reading texts could have serious implications for progress in learning to read. Working in collaboration with a graduate student at Peabody, it is planned to have kindergarten and primary teachers rate vocabulary lists as indicated above. If such ratings indicate that teachers of blind children consistently identify certain words in basic vocabulary lists as abstract, further study will be made. This will consider the effects of use of abstract material in teaching beginning Braille reading. If these are serious, basic vocabularies for blind children will be developed.

c. Determination of Experience Levels Through Ability to Recognize Small Objects:

The amount and range of experience of the young blind child is one factor

which determines his ability to initially profit from educational situations. Children who lack a variety of concepts based on concrete experience are not only handicapped in learning to read, but are poor educational risks generally. The purpose of this study is to develop a means of inferring the breadth of a blind child's previous experience from his ability to identify small objects associated with a variety of areas of experience.

Beginning with small, common household objects and ranging outward into peripheral experience areas, objects will be identified that appear to vary in their accessibility to blind children according to amount of experience. Using teachers judgments, these objects will be scaled into groups according to the average age at which concepts of them are formed by blind children. The scales will then be refined by actual use with large groups of blind children. If successful, this work should result in a measure which will enable inferences to be made of a given child's experience level on the basis of how he compares in object recognition with groups of blind children at specific age levels.

d. Determination of Experience Levels Through Ability to Recognize Sounds:

This study, which is to be done in collaboration with a student from Peabody, will be identical with the above study except that the stimuli to be recognized will be recorded sounds.

2. Legibility of Combinations of Tinted Inks and Papers:

Research has shown that several combinations of tinted inks and papers are superior in legibility. It is planned to compare legibility of these combinations with combinations currently in use in large type readers. Initially, distance recognition threshold will be the criterion for legibility. If significant differences in legibility are found among different combinations, further research will be done utilizing visual fatigue and reading speed as criteria.

3. Effect of the Oral Method of Administration upon the Scores of the Stanford Achievement Test:

Results among sighted children taking parts of the Stanford Achievement Tests show that there is great variability in the numbers of items children at any grade level attempt. Number of items attempted sets an upper limit on the score possible for any child. However, when the Oral Method is used to administer the Braille test, it results in allowing each child opportunity to attempt all the test items. Since some items will be answered correctly by guessing alone, the scores of blind children in the lower ranges of ability could be seriously inflated. An estimate of the seriousness of this inflation shall be obtained by comparing scores blind children receive under the Oral Method of administration with that which would be obtained if the child were required to read the material himself under a time limit adjusted for slowness of Braille reading. This is a joint research effort with Mr. Carl J. Davis of Perkins.

4. The Abacus as an Aid for Teaching Elementary Arithmetic:

Results of the tryout of the Arithmetic Computation Tests pointed up the need for improving the means by which blind children learn arithmetic. Dr. Andrew F. Schott has developed methods of using the abacus which have greatly increased achievement of sighted children in this area. It is planned to meet with Dr. Schott and attempt to develop similar materials for use with the blind. The effectiveness of the method would be determined through actual use.

5. Evaluation of Pictures Produced Through Tracing:

Examples of pictures reproduced through the method previously described will be sent to educators of partially seeing children for comment. Such comment will be obtained through the use of a structured rating form.

6. User Test of the Maillewriter:

The prototype Maillewriter will be subject to appropriate tests of its quality by various types of users. The criteria for these tests have not yet been selected.

DEPARTMENT OF EDUCATIONAL RESEARCH

ANNUAL REPORT FISCAL 1960

INTRODUCTION

Our educational research program has evolved further during this year. We have broadened our concept of the research role of the Department in order that it may include basic types of behavioral research as well as that which has immediate application to the education of blind children. Such an approach will provide for long term studies of basic perceptual processes which have heretofore been relatively unexplored.

One implication of a broadened program is that the resources of the Department be increased. Efforts to this end have been made in a variety of ways. In order to supplement financial resources, applications for research grants have been submitted to a number of agencies. To date the Department has received one such grant which will provide \$14,000 for research over a two-year period. In addition, grant applications which will provide \$40,000 for research over the next four years are currently pending.

A cooperative program with the Department of Psychology and Social Anthropology at the University of Louisville has provided for an increase in both research personnel and research funds. This arrangement has enabled us to add another psychologist, Dr. Emerson Foulke, to our staff on a three-quarter time basis. We have collaborated with the Psychology Department in planning a research project which was submitted through the University to the Office of Education, HEW for support. Subsequently, a grant of \$15,000 has been awarded for this project which provides for the addition of three part-time workers (one faculty and two graduate students) to the number of individuals engaged in research for the blind.

We have an additional cooperative arrangement under development with Drs. Meier and Vineberg of the Department of Psychology of Vanderbilt University. Our purpose here is to encourage and help these psychologists together with their graduate students to undertake basic behavioral studies of tactual and other perceptual processes of blind children.

Through inservice training, Miss June Morris, Research Assistant in the Department, has been enabled to complete work for the MA degree in psychology at the University of Louisville. As a result of this process, Miss Morris will assume more professional responsibilities in the research program during this coming year.

GENERAL ACTIVITIES DURING FISCAL 1960

General activities include reports on research given at a state meeting of educators held at the Ohio School and at a teachers workshop held at the Virginia School. At this latter meeting a talk on achievement testing also was made. The Director participated in a workshop to consider changes in legislation affecting education and rehabilitation of the blind. A short paper was presented at each

of the meetings of the American Association of Instructors of the Blind and the American Association of Workers for the Blind. Bibliographical and informational service was rendered to a number of individuals and agencies. Work was continued on accumulating and annotating a research bibliography.

RESEARCH COMPLETED DURING FISCAL 1960

1. Roughness Discrimination Test: This work was a continuation of a project initiated the previous year. Its purpose is to develop a measure of tactual sensitivity which may serve as a predictor of ability to learn to read Braille. Previous work established that differences existed among children in this ability according to grade level. The problem for this year was to determine if a reliable measure of these differences could be developed.

As before, the test required children to identify the rougher of two small squares of sandpaper mounted on a card. Eighteen grit sizes, from 1 to 5 grades apart, were paired to give 75 test items. These items were administered to 98 children in grades K-4 at the Ohio and Kentucky schools who were Braille readers or potentially so.

Results showed kindergarten children and first grade children to score significantly lower than all grades which followed each. However, for succeeding grades ability on the test was about equal. The test had high reliability (.91) and was positively correlated with IQ (.42) and chronological age (.44). The test still failed to provide for a wide enough range of variability of scores and appeared to involve the use of concepts which were difficult for very young children. Plans to solve these problems will be discussed under another heading.

2. Object Recognition Test: The purpose of this study was to explore differences in ability to recognize common objects among individual blind children and blind children in different grades. This was the initial phase of a large effort to determine the usefulness of a tactual test of object recognition in estimating the level of concept development in preschool and primary level blind children.

An object recognition test was developed that consisted of 30 items which were common household objects. These objects ranged from those that young blind children would commonly contact on a daily basis to those that would require considerable exploration in order to obtain contact. The task for the child, of course, was to name the object. These items were administered to 55 children in the junior nursery, senior nursery, kindergarten and first grade of the Western Pennsylvania School for Blind Children and 23 children from the kindergarten and first grade of the Kentucky School.

Individual performance on the test was quite consistent as is indicated by a test reliability of .87. Significant differences in mean scores were found among all grades except kindergarten and first. Mean scores increased with grade level. Individual variability was quite extensive as is indicated by the total mean of 22 and standard deviation of 5. The results strongly support the feasibility of using object recognition as an estimate of concept development and experience level for young blind children. Work in this area will be continued.

3. Teacher Evaluation of Large Type Pictures: Last year results of research indicated that large type readers found an outline tracing with areas blocked in for contrast more legible than several other modes of reproducing colored pictures in black and white. While this evidence was fairly conclusive,

it was believed desirable to seek the opinions of teachers of partially-sighted children on this matter before widely utilizing such pictures in large-type books. For this purpose, teachers were asked to express their preference for black and white reproductions of five colored pictures made through tracing and the photo-offset method. Participating were 25 teachers from large type classes in the public schools of Ohio and 85 large type teachers in 25 residential schools for the blind.

Ninety-one percent of the total number preferred the traced pictures. Results were comparable for public and residential school groups. A number of teachers reported reactions of their students to the pictures. For a total of 87 students, 85% preferred the traced version. It was concluded that traced pictures should be used to reproduce colored pictures not suitable for reproduction by current methods.

4. Legibility of Ink and Paper Color Combinations: Large type texts have traditionally been printed in black ink on light buff or cream paper. One publisher has recently shifted to black on off-white and research findings have reported several additional combinations which are highly legible. The purpose of this study was to compare legibility of several such combinations using large type readers as subjects. These were 12 students at the Kentucky School for the Blind and included a variety of types and degrees of visual disability. The task for each subject was to identify correctly the clockwise position of the opening of the letter C as it was reduced in size through successively equal steps. The stimuli were printed in both black and blue ink on papers of the following five tints: white, off-white, light-buff, ivory, and canary.

Analysis of variance of the results indicated that there were no significant differences in legibility for ink, paper color or their interaction. Subjective observations suggested that an interaction between type of visual disability and paper-ink color combinations may exist.

5. Tactual Discriminability of Areal Symbols: The purpose of this study was to identify a number of tactual patterns that were clearly different from one another. Such patterns could then be used to symbolically portray areas on Braille maps. The media for reproducing the patterns was Virkotype printing which used plastic ink to give an embossed image. Twelve patterns were selected on the basis of previous research findings. Each was paired with itself and every other pattern on a total of 78 stimulus cards. Ninety-six Braille readers, grades 4-12, in residential schools in Missouri and Illinois were asked to judge whether the pair of patterns on each card was alike or unlike. Five patterns were identified none of which were confused with any other more than 10% of the time. Average confusion between all five patterns was less than 3%. There were no differences in ability to discriminate patterns when children were grouped by grade level and sex. The five discriminable patterns together with seven additional patterns were later similarly studied using 52 children from the North Carolina School. This effort resulted in the identification of three additional highly discriminable patterns giving a total of eight.

6. Learning to Recognize and Recall Tactual Symbols for Areas: This study investigated the facility with which verbal symbols could become associated with the tactual symbols for areas and how well such associations are retained. Six of the symbols previously identified were paired with six letters from the New International Phonetic Alphabet. After two trials of feeling the symbol while

hearing the name of its paired letter, subjects were required to guess the letter upon feeling the tactual pattern. The correct letter name was given following each guess. Each subject received 10 randomly ordered sets of trials each day until he had given the correct letter associations for the 6 tactual patterns twice in a row. After a period of 28 days this process was repeated. Subjects were twenty Braille readers of both sexes, grades 4-11, from the Kentucky School for the Blind. Results of the study showed that tactual patterns of this type can quickly become associated with words and these associations be accurately retained over a period of 28 days.

7. Oral and Written Administration of Achievement Tests: This was a joint study with Mr. Carl J. Davis of Perkins. Its purpose was to investigate comparability of results when achievement tests are administered through the oral or written method. The test used was the Word Meaning Test of the Intermediate and Advanced Batteries of the Stanford Achievement Tests. Form M of this test was put into a Braille form which required children to read the question and circle the correct answer. Time allowed was 30 minutes. Administration of this test was followed in one week by administration of Form K using the oral method in which the testor reads the question and the student circles one of four possible answers. These tests were administered to 336 Braille readers in grades 5-9, who were enrolled in the North Carolina, Maryland, and Perkins schools.

For each Battery it was found that the oral method of administration resulted in a significantly higher score than the written administration. This effect was more pronounced for lower grade levels within a battery. The corrections for use of the oral method established by Hayes would in most cases result in an underestimate of achievement of achievement of pupils when compared with that obtained by the written method.

8. Lavender Braillewriter Operator Research: Operational characteristics of the prototype of the Lavender Braillewriter were studied during the year. Early in 1960 the writer was taken to the Indiana School where it was used by a number of students and faculty and their comments recorded. Ease of paper insertion was checked empirically with a group of 20 first and second graders. After brief instruction it was found that 95% of this group could learn to correctly insert the paper in three trials or less.

Writing speed and fatigue factors were studied using an eight year old female third grade student. This child alternated daily between use of the Lavender writer and another popular writer for several weeks. Each day she wrote continuous alphabets for a 30 minute period. Fatigue effects for the two writers appeared equal. The Lavender writer appeared slightly faster in operation than the comparative writer.

RESEARCH PLANNED FOR FISCAL 1961

1. Future Revision of the Roughness Discrimination Test: Two problems encountered with last year's version of this test were; (a) insufficient range of scores and (b) conceptual difficulties for the very young. A revision of the test is planned that should overcome these difficulties. The individual test items will be changed from two-choice to four-choice items which will increase the theoretical range of test scores from 39 to 59. The four-choice test items will consist of 4 squares of sandpaper, one of which is different in roughness from the other three. Instead of requiring children to identify the rougher of

two stimuli, they will be asked to indicate the square that feels different. The revised test will be evaluated similarly to that of last year. In addition, the relationship between score and current mental age will be estimated.

2. Development of the Object Recognition Test: A larger number and greater variety of objects will be investigated for possible inclusion as items in the test. It is hoped to develop a test to estimate concept development in blind children between ages 3-10. At this time it is not known whether the test will be developed as age scale or a point scale.

3. Tactual Symbols: The results of the studies of areal symbols have already been summarized. This year we plan to repeat both the discrimination and learning studies for symbols that can be used to represent lines and points. The only major change in procedure is that we will study 18 symbols simultaneously instead of 12. This activity will comprise four different experiments.

4. The Abacus as an Aid for Teaching Elementary Arithmetic: This is an experimental application of Dr. Schott's methods of teaching elementary arithmetic. It will take place in first and second grades of the Kentucky, Missouri, Michigan, Virginia, and Western Pennsylvania schools. Teachers received training in the method this summer and we have adapted the Numberaid to use by blind children. Arrangements have been made for Dr. Schott to consult periodically with the schools involved. Achievement of these children in arithmetic will be tested twice yearly.

5. Reading - Listening Comprehension Study: We are undertaking this research jointly with the University of Louisville. It is planned to investigate the extent to which comprehension of blind school children for two different types of materials is determined by mode of presentation. Groups totalling 320 blind children in grades 6, 7, and 8 will be tested on comprehension of two 2100 word passages which consist of literary and scientific material respectively. This material will be presented through Braille and through recordings with word rates for recordings varying systematically from 175-425 wpm.

6. Cues in Reading Braille by the Whole Word Method: It is planned to investigate the cue values of such factors as individual letters, letter position, letter groups, Braille contractions, word length, word shape, part words and context in reading whole Braille words. Work this year may proceed no further than development of a device called a tachistotactometer which will be used to present Braille stimuli to the subjects. It is hoped results from this study will help us better understand the perceptual processes in Braille reading. It is possible that such information would help in speeding learning to read or the actual reading process itself.

7. The Role of Distance, Direction, Practice and Retention in Sound Localization: Here we want to investigate the effect of practice and of distance separating the listener and a sound source upon ability to estimate the direction of a sound. Interactions between practice, distance, and variations in direction will be investigated. In addition, memory and forgetting of associations formed during practice will be studied. Subjects in this study will be children at various age levels and findings should have implications for teaching children how to move about in their environments.

8. Cues Used by Blind Children in Categorizing Objects: This is a pilot study in research on concept development in blind children. It is an attempt to identify the types of cues children use to categorize objects at different developmental levels. The task for each child will be to sort a series of objects into categories. The series of objects will be designed so that each may vary according to shape, size, weight, sound, texture and perhaps odor or any combination of these. Initial efforts will consist of attempts to identify patterns of cues and frequency of their use.

These studies represent those which have been formally planned for this year. It is possible that additional studies may be undertaken as a result of practical needs of the Printing House or that one or more of the above studies may be dropped or delayed. However, other things going well, these will be undertaken between now and June.

In concluding this report, it may be well to reiterate the thought that research can never be other than a cooperative undertaking. Any results obtained during the previous year owe their existence to the collaborative activity of the many people involved. These include Mr. F. E. Davis, the staff of the American Printing House, the staff of the Department of Educational Research, the Educational Research Committee, educators of the blind to include administrators and teachers, and, not least, the many blind children who have borne our sometimes not too tender research ministrations stoically if not always joyfully.

American Printing House for the Blind

INCORPORATED

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Department of Educational Research

Annual Report - Fiscal 1961

General

The research year just completed has been a year of high interest for us and a year in which, as usual, we have met with mixed success. In two studies findings have been obtained which give evidence for potential major advances in critical problems of the education of blind children. On the other hand, a major study of two years duration has encountered obstacles which necessitate a complete re-orientation for the project. Results and progress in several other studies have varied between these extremes.

Efforts to establish cooperative research arrangements with various groups were continued. The cooperative research effort with the University of Louisville has been quite successful. Our joint study has been completed and several masters' theses are underway. A similar situation under development at Vanderbilt resulted in the completion of several theses this year. However, resignation of the faculty members involved has terminated this arrangement. In the past, we have worked with the Department of Psychology and Guidance of Perkins School for the Blind on problems of achievement testing. This work will be resumed during the coming year.

Some personnel changes have taken place in the Department. By the first of the year Dr. Foulke will have changed the locus of his activities from APH to the University of Louisville where his principal role will continue to be that of research in the problems of blindness. At the start of September, we were pleased to obtain the services of Mr. Cleves Kederis on a half-time basis. Mr. Kederis is completing work on a MA degree at the University of Louisville and will initially be employed in our studies of Braille reading.

Progress of Specific Studies

Roughness Discrimination Test Development.

For several years we have attempted to develop a measure of tactual sensitivity which might serve as a predictor of the ability of very young children to learn to read Braille. Results obtained from previous forms of this test have been encouraging. However, previous forms have failed to provide for a wide enough range of variability of scores and have appeared to involve the use of concepts which were difficult for very young children. The test was revised this year to overcome these deficiencies.

As in previous forms, the test required children to discriminate differences in the texture of squares of sandpaper. Eighteen different textures of sandpaper, in which grit sizes ranged from 24-600, were used to construct the test

items. The revised items consisted of 12.5" x 3.5" cards upon which were mounted four pieces of sandpaper 2" square. Three squares of sandpaper were of equal grit size while the fourth was of a larger grit size. In no case were grit sizes compared that were more than five grades apart. The serial order of the various combinations of grit size as well as the position of the rougher square within items were randomized using a table of random numbers. The task for each subject was to identify the square of sandpaper that felt different from the rest on each of 75 test items.

The test was given to 140 children in grades kindergarten through four of the Ohio and Kentucky Schools for the Blind. As before, kindergarten and first grade children scored significantly lower than the other grades and improvement in ability to discriminate degrees of roughness appeared to level off at the second grade level. Reliability of the test was found to be .92. The correlation of the test with chronological age was .33 and the correlation with mental age was .45. The range of variation for test scores in this group was from 15 to 69 correct discriminations. Technically speaking, this form of the test appears acceptable.

Plans have been made for validation of the test during the current year. In late September and early October the test will be given to 100 Braille students in each of the first and second grades. Second grade students will be given an oral reading test at the time of testing and first grade students will be given an oral reading test in April or May near the end of school. Correlations between the roughness test scores and the reading scores should indicate the usefulness of the test in predicting ability to learn to read Braille.

Tactual Symbols for Lines and Points.

This project is a continuation of work done last year on areal symbols for graphic use and is supported by a research grant from the Federal Office of Vocational Rehabilitation. Previously, eight highly discriminable symbols for areas had been identified and shown to be symbolically useful. Our purpose this year was to undertake similar research in order to identify discriminable tactual symbols for lines and points.

The tactual symbols studied were reproduced in Virkotype printing which uses a plastic on ink to give an embossed image. Eighteen potential symbols of each type were paired on 3" x 5" cards with themselves and with each other resulting in 171 pairs of each type. Ninety-six Braille readers, grades 4-12, in residential schools in Texas and Indiana were asked to judge whether the pair of symbols on each card was alike or unlike. Results were that many pairs of different symbols met the criterion set for discriminability, however, only four linear symbols and one point symbol met the criterion of 10% or fewer errors when compared with themselves. Since the ratio of possible "unlike" judgements to "alike" judgements was so great, it appeared possible that a response set for judgements of "unlike" might have occurred. Subsequent testing carried out at the Tennessee School for the Blind proved that this was not the case.

In working with the areal symbols reproduced in Virkotype, we had noticed that there were visually detectable differences in the surfaces of copies of a given symbol. However, analysis of the data did not reveal that this factor affected the judgements of the subjects. Since the line and point symbols were much smaller in area than the areal symbols it was suspected that small variations within symbols resulting from the production process might have far greater effects.

If this were true confusion of "like" pairs, it should occur more frequently among highly sensitive subjects than among subjects low in sensitivity. Comparison of errors for these two groups showed that the more sensitive group made a significantly greater proportion of errors on "like" pairs of both linear and point symbols. As a result of these findings study of symbols reproduced in this medium was discontinued.

Our plans for the current year call for replication of all previous work using symbols reproduced in a new medium - vacuum formed plastic. Preliminary work in this medium indicates that a high degree of legibility can be obtained and that this medium has considerable versatility.

Experimental Arithmetic Program - Level One.

An experimental arithmetic curriculum, which employs an abacus as a primary teaching tool, was studied this year. This program, developed by Dr. A. F. Schott, takes elementary children (grades 1-4) successively through the steps of counting, addition, multiplication, subtraction, and division in each of two cycles during the school year. Through use of the abacus, children are able to observe actual arithmetical operations in concrete terms and learn to describe these operations verbally. The method takes arithmetic out of the abstract and expresses it in behavioral terms appropriate to the level of maturation of elementary level children.

During the previous year, this program was introduced in grades one and/or two in the Kentucky, Michigan, Missouri, Virginia and Western Pennsylvania Schools. Achievement tests given at the end of the school year showed first grade Braille readers to be two months accelerated in achievement and first grade large-type readers to be six months accelerated in achievement. In the second grade both Braille and large-type readers were two months retarded in achievement. These findings were quite encouraging when compared to the average seven month retardation found for similar groups tested in these same schools in 1958. It should be pointed out that this year's results were obtained with inadequately trained teachers using entirely oral methods due to a lack of appropriate text materials.

The results obtained this year appear to justify continuation of the program and it is planned to continue study of the curriculum over the next three year period. To accomplish this, a special two week training program for primary teachers was held at the Western Pennsylvania School during the summer. All necessary text materials were adapted and reproduced in both Braille and large-type. In addition, a special device was developed which enables children to efficiently record arithmetical operations in Braille.

The same schools will be involved this coming year with the exception that Maryland will replace Missouri. Children in all the schools will be tested for achievement at the end of each school year.

Comprehension of Rapid Speech by the Blind.

This project was undertaken jointly with the University of Louisville and supported by a research contract under the Cooperative Research Program of the Office of Education, HEW. Its purpose was to compare comprehension of materials

presented at accelerated speech rates with that of materials presented at normal speech rates and in Braille. Two types of material, one literary and one scientific, were presented to subjects in Braille and aurally at rates of 175, 225, 275, 325 and 375 spoken words per minute. Subjects were 291 Braille readers from grades 6-8 of 11 residential schools for the blind. The subjects were randomly divided into approximately equal groups each of which was exposed on successive days to both types of material under one mode of presentation. Tests of comprehension were given immediately after exposure to the material.

It was found that comprehension for both types of material when presented aurally at 275 words per minute compared favorably with that obtained after reading the materials in Braille or hearing it at the ordinary rate of speech which was 175 words per minute. Further research on this problem will be continued independently at the University of Louisville during the coming two years.

Cues in Braille Word Recognition.

A grant from the Institute of Neurological Diseases and Blindness of the National Institutes of Health has enabled us to undertake this project. Its general purpose is to provide greater understanding of perceptual factors in Braille reading through identification of the cues which provide for whole word reading. Such factors as individual letters, letter position, letter groups, contractions, word length, word shape, part words and context will be studied. Development work on an instrument which will allow us to undertake this project has just been completed. This device, called a tachistotactometer, was developed in collaboration with Lafayette Instrument Company of Lafayette, Indiana. Testing of the prototype is currently underway through study of the comparative legibility of Braille characters. As soon as this investigation is completed systematic study of the factors mentioned above can begin. This research will be continued over the next several years.

Braillewriter Market Study.

In order to plan for production of the Lavendar Braillewriter, it was desirable that some information be obtained concerning the potential market for a writer of this type. This market appeared to include such groups as the adult blind, parents of blind children, volunteer transcribers, and the day and residential school systems. In order to estimate the total potential market for the writer, it would be necessary to sample each of these groups. Identifying members of all these groups and surveying a sample from each would be a costly and time consuming process. However, members of one sub-group, residential schools, were already identified. Since most writer sales by APH are made to the schools, this appeared a fruitful area within which to make a market survey.

Survey materials were sent to 46 residential schools for the blind of which 38 replied. Results of the survey indicated a need for a large number of writers among this group. Purchase of writers was found to be directly related to the unit cost indicating that production of a writer at a relatively high cost would not be conducive to alleviating the need for Braillewriters within the schools.

Word Association Study.

This study is an exploration of concept formation in blind children and is an extension of work done previously. It is planned to compare free associations made by blind children to words in the following categories:

- a. Words standing for objects that can be apprehended by four senses.
- b. Words standing for objects that can be apprehended by three senses.
- c. Words standing for objects that can be apprehended by two senses.
- d. Words related exclusively to vision.
- e. Words related exclusively to hearing.
- f. Words related exclusively to haptic perception.

Associations shall be classified according to such criteria as appropriateness and frequency. As many words as possible were chosen from the modified Kent-Rosenoff word list in order to make possible comparison of responses with other groups. Factors such as age, sex, grade, IQ, degree of visual impairment, age at onset of visual impairment, and others will be considered in the analysis of results.

Some data for this study were gathered last year at the Arkansas School for the Blind. Data will be gathered on approximately 1000 subjects as opportunity arises. It is anticipated that the study will continue for several years.

Miscellaneous.

Members of the Department have engaged in a number of diverse work-related activities during the year. Dr. Foulke and the Director participated in a national meeting on research needs in our field held by the Office of Education, Department of Health, Education, and Welfare. The Director coordinated a meeting on text materials jointly sponsored by AFB-APH, delivered a paper on our research at the national CEC meeting in Detroit, spoke to groups of students and teachers at Vanderbilt University, Peabody College, the Ohio School for the Blind and the University of Louisville, attended an additional conference on research needs at the Office of Education, HEW, and wrote a chapter reviewing educational research on the visually handicapped for a forthcoming CEC monograph.

Studies Planned for the Coming Year

In addition to continuation of projects as already described, tentative plans have been made for the initiation of several new projects. These are briefly described in the following paragraphs.

Evaluation of the Soroban as a Computing Device for the Blind.

Difficulty with arithmetic computation has long plagued the blind. Much of this is due to cumbrousness of the processes and devices employed. Results obtained last year in using an abacus to teach arithmetic to elementary grade children indicate the utility of this device for the blind. Everyday use of the abacus as a computing tool by thousands of people in the Eastern Hemisphere give proof of its reliability and speed.

The soroban is an abacus having one bead above the stop and four below. A special version modified to insure legibility for the blind and with friction induced in the counters will be produced by APH. Fifty blind adults will be trained in the use of these devices by home-teachers. Before and following training the computational skill of subjects will be evaluated using speed and accuracy of computation as criteria.

This will be a joint study with the Kentucky State Bureau of Rehabilitation Services. Its initiation is contingent upon the award of a grant by OVR.

Increasing Braille Reading Speed through Paced Practice.

In his field test of the IBM Braille Reader, Dr. S. C. Ashcroft of Peabody found that subjects, after ten hours of practice with the device, were able to increase their reading speed for conventional Braille by about 20-45%. This suggests the utility of this device as a "reading accelerator" for use in training designed to increase Braille reading speeds. Ashcroft employed only 9 adult subjects. More data must be collected in order to substantiate his results.

We plan to set up a training program which will force readers to read Braille at increasingly faster rates. Pacing will be achieved by utilizing the variable speed of the IBM Braille Reader. Subjects will be blind high school students who will practice on several types of material characteristic of those normally encountered in their school programs.

Oral and Written Administration of Achievement Tests.

Last year we made a study of the comparability of achievement test scores obtained by blind children when such tests were administered through written methods and oral methods. Findings were that in some cases the results obtained were not comparable. During the coming year we plan to explore the source of these differences further. As before, the study will be a joint project with Mr. Carl J. Davis of Perkins School.

Adaptation of Achievement Tests.

In further collaboration with Mr. Davis of Perkins we hope to adapt additional tests for use with blind children. With the cooperation of World Book Company, work will be begun on adapting the new Stanford Achievement Tests. These tests, which will not be published until 1963, are currently undergoing standardization on a large sighted population. Use of this standardization data in adapting such tests may enable us to construct test forms which will have greater validity for the blind.

In addition, it is planned to explore the possibility of adapting an academic achievement test for blind children in grades 10-12.

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Department of Educational Research

Annual Report - Fiscal 1962

Carson Y. Nolan, Director
June E. Morris, Research Assistant
J. Cleves Kederis, Research Assistant

General

Work on continuing projects has occupied us principally during the work year just completed. While substantial progress in a number of areas has been made, it is not possible to report findings in any area which are final. However, a number of interesting and significant minor findings are available.

The total research effort appears to have achieved more stability with major interest centering in the area of communication as it effects the education of the blind. However, as this report will reveal, the program still possesses considerable breadth and diversity.

Only one minor change in the structure of the Department can be reported. Mr. J. Cleves Kederis, who initially worked for us part-time, assumed a full-time position at the beginning of this calendar year.

Progress of Specific Studies

Validation of the Roughness Discrimination Test

Previous reports have described efforts to develop a test of roughness discrimination for use as a predictor of readiness to learn to read Braille by children in the first grades of school. These efforts resulted in a test of sufficient reliability (.92) for practical use. The test distributes ability to discriminate degree of roughness over a range of 54 score points. Correlations are relatively low between scores on the test and chronological age (.33) and test score and I.Q. (.16). Averages for grades increase significantly from kindergarten through grade two at which point increase in grade averages is greatly reduced and ceases to be statistically significant.

The roughness test is composed of 69 items. Each of these consists of a 3.5" x 12.5" card upon which are mounted 4 pieces of sandpaper 2" square. Three

of the squares are of equal grit size while the fourth is of a larger grit size. The task for the subject is to feel the 4 squares and identify the one that is different from the other 3.

The purpose of the present study was to examine the relationships between Roughness Discrimination Test scores and criteria for Braille reading in order to evaluate the predictive and concurrent validities of the test. Subjects were 186 students enrolled in the Indiana, North Carolina, Overbrook and Tennessee residential schools for the blind. Parts of the Gilmore Oral Reading Test furnished the reading criteria.

During the first month of the second grade, 81 students were given both the Roughness Discrimination Test and the Reading Test. Concurrent validity estimates for this group proved to be .25 for reading errors and .57 for reading speed. One hundred five first grade students (including 19 kindergarten pupils) were given the Roughness Discrimination Test during the first month of the school year and then tested with the Reading Test at the end of the school year. The correlations between these scores were .55 for reading errors and .56 for reading time. All of these validity coefficients are statistically significant at greater than the .05 level of confidence.

The findings indicate that Roughness Discrimination Test scores obtained at the beginning of grade one are useful in predicting the degree of reading success that will be achieved by blind students during the course of the first grade. Since the test requires, on the average, only fifteen minutes to administer and can be administered by relatively unskilled individuals it could prove quite useful to first grade teachers in grouping children for initial reading instruction.

During the coming year additional data will be gathered in order to substantiate the predictive validity of the test for first grade students. This will allow for consideration of such factors as age-for-grade and previous kindergarten experience. In addition, an increase in the number of available cases will enable norms for the test to be constructed.

Tactual Symbols for the Blind

The education and rehabilitation of the blind require embossed materials which employ both verbal and graphic forms of communication. Braille, which is highly developed and standardized, fills the requirement for embossed verbal communication. However, the means available for embossed graphic communication, i.e. maps, graphs, charts and diagrams are still relatively crude. Lack of identification of clearly discriminable tactual symbols has seriously impeded development in this area.

Three types of symbols; areal, linear and point are needed for graphic communication. The number of discriminable tactual symbols possible in any given size and type appears to be dependent upon the medium in which the symbols are reproduced. Previously the use of virkotype as a medium for producing symbols of this type was investigated and found not to be feasible.

The purpose of this past year's research in this area was threefold. First, it was to determine whether vacuum formed plastic would be an appropriate medium in which to make symbols. Second, it was to identify 3 sets of symbols (areal, linear and point) that would be highly discrete. And third, it was to establish whether verbal associations could be made and retained in relation to

a given set of symbols.

Fourteen symbols for points and 13 symbols for lines were produced in vacuum formed plastic. Each type was paired with each of the other symbols of its type and with itself so that they could be evaluated by the method of pair comparison. This resulted in 105 and 91 combinations respectively. These were then judged by 96 students in grades 4-12 from the Florida, Louisiana and Missouri schools for the blind. Using a criterion of 10% maximum error for any pair, 7 linear symbols were found to qualify. From the evidence available at this point it was decided to slightly redesign several of the point symbols and test the new set. This was done and 9 symbols of this type were paired in a pair comparison arrangement giving a set with 45 combinations. These were judged by 72 students in grades 4-12 at the Ohio State School for the Blind. Eight of these were found to be highly discrete. In similar fashion, 13 vacuum formed plastic areal type symbols were paired yielding 91 combinations. These were judged by 92 students, grades 4-12, in the Ohio and Western Pennsylvania schools for the blind. From this group 7 were found to be highly discrete.

Having found that the vacuum formed plastic medium had provided the means from which 3 separate sets of discriminable symbols had been produced, it can be assumed that this is a feasible means for producing graphic symbols.

The third question explored in this area was the learning of names for these symbols and the retention of these names once learned. Since this had previously been ascertained for areal type symbols produced in virkotype, a set of this type having proven discrete; this past year only the linear and point symbols were studied. Eight point symbols and 9 linear symbols (those just above the error tolerance for being labeled as highly discriminable were included) were assigned a meaningless name from the International Phonetic Alphabet. Two groups of students from the Kentucky School for the Blind, grades 4-12, were used in this phase of the tactual symbol study. Eleven subjects learned names for the linear symbols while 10 other subjects learned names for the point symbols in a paired associates experimental design. Twenty-eight days after having learned names for the symbols the subjects were tested to see how well they retained the names. The results of this phase of the study indicated clearly that subjects could learn names in association with tactual graphic symbols and retain the associations over a period of time.

The study of tactual symbols will be pursued in the coming year. The next step will be to determine the minimum size, in area, that will be useable for the areal type symbols. When this information is at hand it will be possible to make up experimental graphics in order to determine the best combinations of the 3 types of symbols.

Experimental Arithmetic Program - Level One

The purpose of this project is to evaluate experimentally arithmetical achievement of elementary level blind children instructed under a new arithmetic curriculum developed by Dr. Andrew F. Schott featuring the abacus as a teaching tool. The curriculum takes elementary children (grades 1-3) successively through the steps of counting, addition, multiplication, subtraction and division in each of 2 cycles during the school year. Through use of the abacus, children are able to observe actual arithmetical operations in concrete terms and learn to describe

these operations verbally. The method takes arithmetic out of the abstract and expresses it in behavioral terms appropriate to the level of maturation of elementary level children. This is particularly important in the case of blind children in that numbers and arithmetical concepts are expressed on the abacus under the finger tips. In the case of sighted children, after learning has occurred, the abacus is discarded. For blind children it may be retained in some form as a computing tool.

The second year of the Experimental Arithmetic Program commenced with a workshop for all teachers who would be taking part in the program. This was held during the summer of 1961 at the Western Pennsylvania School for Blind Children with teachers attending representing the Kentucky, Maryland, Michigan, Virginia and Western Pennsylvania schools for the blind. During the preceding year the program had gotten off to a good start even though at that time much of the equipment was not available until well into the school year and many of the teachers were inadequately trained. During the school year 1961-1962 the necessary equipment which includes Numberaids (a type of abacus) adapted for use by the blind, Calculaids which are devices upon which arithmetical operations can be recorded in Braille, and accompanying workbooks in both Braille and large type was available from the start.

During this year 173 Braille students and 38 large type students in grades 1-3 participated in the program. These were tested in the ninth month of the school year with either the Primary or Elementary Battery of the Stanford Achievement Tests, Form J, Arithmetic Computation Test. The test was reproduced in 18-point type for large type readers and standard times were used. For Braille readers the test was administered orally using the standard time limits.

Keeping in mind that the norms for the Stanford Achievement Tests are in terms of a sighted population and that blind groups average from 7 to 11 school months behind their sighted peers in arithmetic achievement, the following results are highly encouraging. The median score for the 80 Braille students in the first grade and the 22 large type students in the first grade was 2.3 which is 4 months over the norm. The 58 Braille students in the second grade were at grade level (2.9) while the 9 large type students were 2 months behind having a median score of 2.7. The Braille third grade group of 35 students had a median score of 3.6 showing 3 months retardation while the small group of 7 large type third grade students had a median score of 2.9 indicating a years retardation. Other than this latter group, all did markedly better than would be expected if they had been taught by previous methods.

The groups that were in the first grade during this past year are the ones that will be observed and followed most acutely during the duration of the evaluation of the Experimental Arithmetic Program. Present plans call for this study to be continued during this year and perhaps next.

Cues in Braille Word Recognition - The Legibility of the Braille Characters

The legibility of the 55 single cell Braille characters that represent letters, letter groups and word forms was established during the year by means of the Tachistotactometer, a machine developed previously by the Department of Educational Research under a grant from the National Institutes of Health. Only 2 previous efforts have been made to determine the legibility of the Braille

characters (Uniform Type Committee, 1913-1915; Karl Burklen, 1917), and their findings were not in close agreement. The present study was designed to shed more light on this issue and, also, to define some of the methodological and subject matter problems that might be encountered in such investigations.

Average recognition threshold values for each of the characters were obtained from 18 male and 18 female, blind, skilled Braille readers in grades 4-12 at the Kansas, Kentucky and Tennessee schools for the blind. This data along with the incorrect responses to each of the stimulus characters were used to assess the effect of the number and configuration of dots on the readability of the characters.

The findings were, for the most part, consistent with the Uniform Type Committee's. Legibility was found to be principally a function of the number of dots (as the number of dots in the characters increased, the average recognition threshold times became longer). The shapes of the characters were involved to a lesser extent and in an indeterminate way. In a majority of instances the shape of the dot configurations in the stimulus and the incorrect response was similar. Missed dots was the most important type of error. No other characteristic of the symbols was found to have a significant effect upon recognition.

Pilot Study of the Relative Learning Achieved through Reading and Listening by Blind Children

The recent studies on the efficiency of comprehension by listening to compressed speech as well as recent developments in the technical aspects of recordings have emphasized the need to explore the relative usefulness of audition and reading as means of learning by blind children. This study was undertaken to explore some of the methodological problems involved in such research as well as to confirm some of the already existing findings resulting from research using sighted children.

The design of the experiment called for a comparison of the amount of learning occurring when blind children read or listened to a 2100 word passage of scientific material dealing with circulation of the blood. Seventy students in grades 6-10 at the Perkins School for the Blind were divided into 7 groups which were equated for grade level. Three groups were designated as reading groups and 3 groups were designated as listening groups. Groups under each condition of the experiment were then required to read or listen to the experimental material for 2, 4 or 5 consecutive days. At the end of their respective number of practice days each experimental group was administered a test for amount of material learned. The seventh group, which was designated control, was also administered the learning test, however, without being exposed to the material.

Analyses of the results reveal that all the experimental groups achieved a significantly higher score on the learning test than the control group. Differences in the amounts of learning among experimental groups were analysed using covariance techniques in order to statistically equate the groups for intelligence. Results of these analyses reveal no differences among experimental groups with respect to mode of presentation of the material or the amount of practice assigned.

Perhaps the most interesting result was the difference between these results and those previously described for sighted groups. For the latter groups, reading has almost invariably been found the superior learning method when older

children are required to learn difficult materials. Our results indicate that listening is at least as effective as reading for blind children under similar circumstances.

Additional research is currently being planned for this area.

Oral and Written Administration of Achievement Tests

Research previously conducted in collaboration with Perkins to investigate comparability of results obtained through oral and written achievement testing was replicated during this last year. The test used was the Word Meaning Test of the Intermediate and Advanced Batteries of the Stanford Achievement Tests. Form M of this test was put into a Braille form which required children to read the question and circle the correct answer. Time allowed was 30 minutes. Administration of this test was followed in one week by administration of Form K using the oral method in which the tester reads the question and the student circles one of 4 possible answers. These tests were administered to 196 Braille readers in grades 5-9 who were enrolled in the Michigan, North Carolina, Perkins and Virginia schools during this past year.

As before, for each battery it was found that the oral method of administration resulted in a significantly higher score than the written administration. This effect was most pronounced for lower grade levels within a battery. The corrections for use of the oral method established by Hayes would in most cases result in an underestimate of achievement of pupils when compared with that obtained by the written method. However, many extraneous factors appear involved in which method proves superior by giving higher scores.

Word Association Study

Due to methodological difficulties that arose early during the data collection phase of this experiment, work in this area was halted and has not been resumed.

Miscellaneous

Members of the Department of Educational Research collaborated with the production department of APH in further field tests of the Lavendar Braillewriter and in other products involving tangible apparatus.

The Director presented papers at the annual meetings of the Southeastern Psychological Association, Council for Exceptional Children and AAIB. In addition to attending a meeting on curriculum development sponsored by the United States Office of Education, the Director participated in meetings of the AAIB Research Advisory Committee and in meetings of the Braille Authority's Committees on Research and on Textbook Format.

Studies Planned for the Coming Year

Effects of Familiarity, word length and Braille Orthography

During the current year an attempt is being made to determine the extent to which Braille words are read by individual characters or as wholes.

Fifty-four Braille words were classified according to (a) word type (familiar, unfamiliar and nonsense words), (b) word length (3, 5 and 7 characters) and (c) Braille orthography (contracted and uncontracted words) - 3 words in each category. By means of the Tachistotactometer these words have been presented to 10 students ranging in age from 9-20 years at the Kentucky School for the Blind.

The data have not been completely analysed, but the results of an analysis of variance show a significant effect due to familiarity and word length. Whether a word is contracted or uncontracted appears inconsequential.

This and similar studies of such factors as individual letters, letter position, letter groups, part words, word shape, word meaning and context are planned during the year. Moreover, an attempt will be made to determine the effect of such subject variables as intelligence, age, grade and years of practice with Braille.

Increasing Braille Reading Speed through Special Training

The Office of Vocational Rehabilitation recently awarded us a grant to conduct two studies of this type. The first will give Braille readers practice in reading words and phrases of Braille at steadily diminishing exposure times. The second will give Braille readers practice in prose reading under conditions where the rate of presentation of material is steadily decreased.

The device used to vary the exposure time of Braille material will be the Tachistotactometer. Subjects will be given one half hour practice session on each of 20 consecutive school days. Practice materials will vary from short to long words during the first half of training and from short to long phrases during the second half of training. Exposure times for the stimulus materials will be systematically reduced during the course of practice according to the recognition skill of the individual subject.

The device used to vary the rate at which prose material is presented will be the IBM Braille Reader. Subjects will be given 20 one half hour practice sessions on successive school days. Initial reading rates will be set near those determined characteristic of the individual subjects. Reading rates will be increased systematically during practice.

Results of the training will be evaluated by scores obtained from administration of the 4 equivalent forms of the Gates Basic Reading Test, Type A. The reading rates and comprehension scores established immediately prior to training will be compared with similar scores obtained immediately following training and at intervals of 30 and 60 days thereafter in order to determine the effects of training and the degree to which these effects hold up with time.

Evaluation of the Soroban as a Computing Device for the Blind

Difficulty with arithmetic computation has long plagued the blind. Much of this is due to cumbrousness of the processes and devices employed. Results obtained during the past two years in using an abacus to teach arithmetic to elementary grade children indicate the utility of this device for the blind. Everyday use of the abacus as a computing tool by thousands of people in the Eastern Hemisphere gives proof of its reliability and speed.

The research project planned last year in collaboration with the Kentucky State Bureau of Rehabilitation Services failed to materialize. However, evaluation of these devices is being conducted during the current year. Involved will be approximately 50 students in grades 7-9 at the Perkins School for the Blind and approximately 25 students in grades 6-12 of the Cincinnati Public Schools. All children will be tested for speed and accuracy of computation for problems of varying degrees of difficulty involving the arithmetical operations of addition, subtraction, multiplication and division using whole and decimal numbers. They will then be trained in use of the soroban and after having been given opportunity to gain skill in its use will be tested as before. The hypothesized result is that there will be dramatic increases in speed and accuracy scores as well as in ability to handle more complex problems.

Adaptation of Achievement Tests

Work on further achievement tests for blind children described in last year's Annual Report for this year has been delayed a year. This is due to problems arising within the collaborating agency; Harcourt, Brace & World, Inc.

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Department of Educational Research

Annual Report - Fiscal 1963

Carson Y. Nolan, Director
June E. Morris, Research Assistant
Cleves J. Kederis, Research Assistant

General

The work year just completed may well be the most fruitful in the history of the Department. As in previous years, the research program has consisted of a variety of projects, each dealing with a basic problem area in the education of blind children, i.e., braille reading, mathematics, and educational measurement. Several projects of long duration have been continued and at least two are approaching their completion. Once more, the Department has been able to obtain substantial outside support for major research projects. The personnel structure of the Department has remained stable during the year, however, some increase in personnel is anticipated during the fiscal year 1964.

Progress of Specific Studies

Development of the Roughness Discrimination Test

The development of a test of roughness discrimination for use as a predictor of readiness to learn to read braille by children in the first grades of school has come to a successful conclusion. The test is composed of 69 items, each of which consists of a 3.5 x 12.5 inch card upon which are mounted four pieces of sandpaper two inches square. Three of the squares are of equal grit size while the fourth is of a larger grit size. The task for the subject is to feel the four squares and identify the one that is different from the other three.

The test has a high degree of reliability (.92). Correlations are relatively low between scores on the test and chronological age (.33) and test score and IQ (.31). Evidence for the usefulness of the test in predicting success



in learning to read braille in the first grade is based upon data derived from testing 175 children in 10 residential schools. All children were given the roughness test in the first month of the school year. At the end of the school year all children were administered parts of the Gilmore Oral Reading Test. The correlation between the roughness test score and reading errors was found to be .53, and that between the roughness test score and reading time was found to be .58. Since the test requires only 15 minutes for administration, it is believed that it will provide a convenient screening device for organizing reading groups in the first grade.

Minimum Sizes for Tactual Symbols for Area

In previous research, a number of discrete symbols for area have been identified. The purposes of this study were to establish minimum outer dimensions for each area symbol and to determine whether grade differences exist for the minimum sizes at which students can recognize them. Sixty students in grades 4-12 of the Texas School for the Blind served as subjects.

The experiment consisted of 56 trials. On each trial the subject was required to inspect a stimulus symbol and then pick out an identical pattern from among seven response symbols. The side dimensions for the stimulus symbol were always two inches. The side dimensions for the sets of response symbols varied from two to one-fourth inches in steps of one-fourth inch. The total task consisted of comparing each of seven stimulus symbols with each of eight sets of response symbols of varying size. The order in which the combinations appeared was random.

For each trial, the stimulus symbol and the response symbols were mounted on a 7 x 10 inch card. The stimulus symbol always appeared in the lower right corner of the card and the response symbols always appeared in a row of three to the left of the stimulus symbol and a row of four above and to the left of the stimulus symbol.

Results of the study indicated that the minimum side dimensions at which symbols could be recognized varied considerably and ranged from one-fourth to one and one-half inches. Symbols consisting of patterns of small detail were recognized at smaller outer dimensions than symbols consisting of patterns of large detail. Children in grades 8-12 were able to recognize symbols at much smaller sizes than children in grades 4-7.

Evaluation of the Soroban as a Computational Aid

Research conducted by APH and others has demonstrated the general retardation found among blind children in tests of arithmetic computation. Part of this deficit may be ascribed to the crudity or cumbrousness of the computational techniques commonly employed by the blind. The soroban represents a possible solution to this problem.

The soroban used in this study had 13 columns. On each column, four counters are positioned below the stop and one counter above. The outer dimensions of the device were 3 x 5.5 inches. The counters consisted of small beads. These were backed by layers of felt and sponge rubber which induced enough friction

to make the counters stay in place once they were positioned.

The subjects were 42 students in grades 7B through 9B of the Perkins School for the Blind. During the first week of the project, the teachers of each grade were instructed in use of the abacus. Prior to the start of instruction all students were tested for ability in arithmetic computation. The tests used were the Advanced Arithmetic Computation Test, Stanford Achievement Tests, modified to include only items dealing with addition, subtraction, multiplication, and division of whole and decimal numbers, and the Madden-Peak Arithmetic Computation Test, Parts 1 and 2, which were combined in order of difficulty. Students were retested after four and eight months. It was found that average computational skill (items correct) improved as much as 66% over the eight months. Therefore, use of the soroban appears to be an efficient and practical approach for overcoming the computational problems of the blind.

Preferences for Paper Color for Large Type Books

In recent months, APH has received many comments from educators that the buff colored paper presently used in its large type books is undesirable and that a lighter colored, off-white paper would be better. In order to gain more information on this problem, a survey of the opinions of teachers of partially-sighted children was made in order to determine relative preferences for papers of different colors.

Each subject was sent a package containing nine four-page pamphlets each utilizing a different paper. Colors ranged from a very deep buff to a bright white. Some papers varied only in the hardness of their surface. Printed on the papers was identical school text material including illustrations. The order of inclusion of the papers in the package was randomized among teachers. Each subject was also sent a set of instructions, a rating form, a stamped return envelope, and was requested to rank all the papers from one to nine in order of their desirability for use in large type books.

Materials were sent to 100 teachers in the public schools of Illinois and Ohio. Seventy-seven replies were received of which 64 were completed consistently enough with the instructions to be included in the data analyses.

The findings of the study were that extremely white or color saturated papers are undesirable. While many teachers still prefer a light buff paper, the preponderance of opinion appears to favor an off-white paper.

Training to Increase Braille Reading Speed

One of the two studies planned in this area was completed this year. In this study, two groups of 15 students each from grades 6-12 of the Illinois School were matched on reading comprehension and grade level. One group was given one half-hour of reading training on 20 consecutive school days while the second group served as a control. The training given the experimental group was of the controlled exposure variety. Students were required to read materials which were exposed for progressively shorter and shorter time intervals. As the training proceeded, the difficulty of the practice material increased through short words to long words and short phrases to long phrases. After the training

period both groups were retested with an equivalent form of the matching test. A second equivalent form and third equivalent form were administered at 30 and 60 days after the retest. On the initial retesting both groups were tested together and a monetary reward offered to the three persons from either group who most increased their reading speeds over those obtained in the matching test.

The experimental group increased its reading speed by 25% and this increase in rate held 30 and 60 days after training had stopped. However, the control group also increased its reading speed by 25% and this increase held through 60 days. The experiment did not demonstrate the effectiveness of the training, but something that has been recognized for a long time: that motivation is the key to the development of reading speeds regardless of the medium. By making reading a challenging task; by stimulating competition among and within individuals; by letting students know periodically how well they are doing, ability can be increased in this area.

The second study of reading training will be completed this fall. In this study the pacing method will be used. The device used to vary the rate at which prose material is presented will be the IBM Braille Reader. Subjects will be given 20 one half-hour practice sessions on successive school days. Initial reading rates will be set near those determined characteristic for each subject under conditions of high motivation. The rate of presentation of material will then be systematically increased during practice. Results of this study will be measured by the methods employed in the study previously described.

This research has been supported in part by a grant received from the Vocational Rehabilitation Administration.

Experimental Arithmetic Program

The purpose of this project is to adapt the Individualized Arithmetic Curriculum for use with blind children and to evaluate its usefulness. This is a modern mathematics curriculum developed for sighted children by Dr. A. F. Schott. In content it resembles the several other modern mathematics programs now in use. Its advantage for the blind is that the curriculum employs a series of tangible aids which enable blind children to engage effectively in necessary mathematical operations in a concrete manner.

The Level One Program: For the past three years, study of the Level One program has been underway in the Kentucky, Maryland, Michigan, Virginia, and Western Pennsylvania Schools. This curriculum takes elementary children (grades 1-4) successively through the steps of counting, addition, multiplication, subtraction, and division in each of two cycles of the school year. It allows children to learn at their own best rates. Through use of an abacus called the Numberaid children are able to observe arithmetical operations in concrete terms and learn to describe these operations verbally. The method takes arithmetic out of the abstract and expresses it in behavioral terms appropriate to the level of maturation of children in the first grades of school. This is particularly important in the case of blind children in that numbers and arithmetical concepts are expressed on the Numberaid under the finger tips. Normally, after learning has occurred, the abacus is discarded. With blind children it can be retained in a different form and becomes an efficient computing tool.

Results obtained in the program this year duplicate those of previous years. Children in grades one and two who started their mathematical training in the program are, on the average, accelerated in achievement in arithmetic computation by three months when compared to sighted children in regular programs. Third grade children are still retarded by about two months; however, many of these children have participated in the experimental program only two years.

This year the performance of students in the experimental program was compared with that of students in six residential schools where more traditional curricula were in use. Achievement of students in the experimental program exceeded that of children in other programs by three to six months when grade averages are compared. The experimental program proved superior to traditional programs when the proportion of students achieving at level of grade placement or above is used as a criterion. Proportions for the grades are as follows:

Grade 1	experimental	.88
	traditional	.59

Grade 2	experimental	.84
	traditional	.21

Grade 3	experimental	.42
	traditional	.18

Present plans call for testing the achievement of students in the program for one more year.

The Level Two Program: The adaptation of the Level Two Individualized Mathematics program was undertaken this year. This curriculum is for use in grades 5-6 and includes such topics as fractions, geometry, linear measurement, measurement of area and volume, factoring, equations and literal numbers, and many others. During the spring and summer adaptations were made of the texts and tangible materials and these are in limited use this year in some of the experimental schools. It has not been decided at this time how this part of the curriculum will be evaluated.

Perception in Braille Reading - Effects of Familiarity, Word Length, and Orthography

Two studies were carried out in this area during the year. Since the first was a pilot study and since its findings were confirmed by the second study, only the latter will be described here.

The object of the study was to compare groups of good and poor braille readers for ease of recognition of 36 words which varied according to familiarity (familiar - unfamiliar), length (three, five, and seven cells), and orthography (spelled in full - contracted). The procedure employed was that of the Method of Limits using only the ascending series. The tachistotactometer was used to present the words at controlled exposure times. Words were initially exposed at times far below those at which they could be recognized. These exposure times were systematically increased until all subjects recognized each word. In a similar fashion

recognition thresholds were obtained for the braille characters included in the set of words.

The subjects were 30 students randomly selected from the upper and lower thirds of the distributions of reading times and comprehension scores made by 75 students in grades 9-12 at the Indiana, Ohio, and Tennessee Schools for the Blind when tested with the Gates Basic Reading Test.

The findings were many. As expected, time to recognize braille words increased as braille words changed from familiar to unfamiliar, short to long, and uncontracted to contracted. These effects were greater for poor readers who took longer to recognize all words. The effects of all the main variables were inter-related in a complex fashion. The results indicated that there may be no such thing as "whole word reading" in the sense of visual reading. The time taken to recognize a braille word can be crudely divided into the time necessary to sense the characters and the time required for meaningful integration of the characters. The relative proportion of time required for each of these behaviors varies according to the characteristics of the word.

It is planned to continue research on perception in braille reading. The design of additional studies has been delayed until additional analyses are made of data already obtained.

This research has been supported, in part, by a grant received from the Institute of Neurological Diseases and Blindness of the National Institutes of Health.

Adaptation of the New Forms of the Stanford Achievement Tests to Braille and Large Type

The adaptation of the new series of the Stanford Achievement Tests has been delayed due to problems experienced by the publisher; Harcourt, Brace, and World. However, it is expected that adaptation of these test to braille and large type will be completed within the next few months. For the first time, a special set of norms for the braille tests will be available. These norms, based on the sighted standardization group, will be especially developed for the specific sets of test items to be included in the braille edition.

Adaptation of the SCAT and STEP Test Series to Braille and Large Type

These tests, published by Educational Testing Service, will also be adapted during the current school year. The School and College Ability Tests are designed to provide measures of abilities which have been found to be most closely related to success in school learning. These include sentence understanding, numerical problem solving, word meanings, and numerical computation. The tests will appear in four levels which can be used in grades 4-12.

The second battery, the Sequential Tests of Educational Progress, is a special kind of achievement test designed to measure the broad outcomes of general education rather than the relatively narrow results of any subject matter course. This series also covers grades 4-12. It includes tests of reading, writing, social studies, mathematics, science, and one which may prove particularly useful - listening.



The tests provide examples of most of the problems encountered when attempts are made to adapt print tests to braille form. Current plans are to use the adaptation of these tests as a general vehicle for the exploration of some of these problems.

Analysis of the Visual Abilities and Modes of Reading by Blind Children

In 1960, John Jones, of the Office of Education, published a study which related degrees of visual disability and modes of reading. This report was based on data accruing from the 1960 registration of children under the act "To Promote the Education of the Blind". The study aroused such interest that it will be replicated using data obtained during the 1963 registration of legally blind children.

Reading and Listening in Learning by the Blind

Previous research by APH and others indicates that in many instances listening may be more efficient than braille reading as a means of obtaining the information normally included in the school curriculum. In addition, children appear to be able to comprehend information through listening when the rate of presentation is increased as much as 57%. It is planned to study this problem extensively during the next four years. The specific purposes of this project are:

1. To determine the relative efficiency of listening and braille or large type reading as a means of learning subject matter of various kinds.
2. Where listening appears useful, to determine the relative efficiency of different rates of auditory communication.
3. To determine listening techniques useful for learning by the blind.

This research will be supported, in part, by a grant received from the Institute for Neurological Diseases and Blindness of the National Institutes of Health.

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Papers given during Fiscal 1963

- Nolan, C. Y. Recent research at the American Printing House for the Blind. Annual meeting of the Council for Exceptional Children, Philadelphia, April, 1963.
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American Printing House for the Blind

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Department of Educational Research

Annual Report - Fiscal 1964

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General

The department was formed in 1952 to conduct basic and applied research on problems of educating visually handicapped children. In the past a variety of topics has been studied including such things as braille reading, listening, legibility of large type materials, map making, predicting readiness to learn to read braille, achievement testing, instruction in mathematics, and concept formation.

During fiscal 1964, the research program continued to be concentrated in the same general areas as in previous years, i.e., tactual and auditory communication, mathematics instruction, and educational measurement. Most of the individual studies undertaken represented but steps in long term research projects. It appears that four long term projects will receive the major part of the research effort during the next three years. These programs will concern perceptual factors in recognition of braille words, mathematics instruction, symbology for non-verbal tactual communication, and the efficiency of listening as a means of learning.

Progress of Specific Studies

Training to Increase Braille Reading Speed

The effects of training braille readers to read faster through the use of pacing techniques were studied during this past year. Previous efforts to increase braille reading speeds, through manipulation of time of exposure of reading materials were unsuccessful.

The pacing device used was the IBM Braille Reading Machine which was adapted so that materials could be presented at rates varying from 50-250 words per

minute. The input for this device was a punched tape and the output was braille material displayed on a moving belt. Subjects in the study were eight fast and eight slow braille readers from the Kentucky school. They were matched on the basis of reading speed and comprehension with sixteen students who served as controls.

In order to provide a base line against which to compare the effects of training and to control for the possible differences in motivation between the experimental and control groups, two pretraining tests of reading speed and comprehension were given. Initially all subjects were tested with the Gates Basic Reading Test - Form A. The following week an equivalent form was administered under motivated conditions, i.e., the three students who most increased their reading speed scores over those obtained on the first test, with no loss in comprehension, received monetary rewards. Scores on the second testing represented approximate gains of 26% in reading speeds over those first obtained. These provided the base line for starting practice and for judging future performance.

The subjects were trained for 30 minute periods on each of 20 successive days. On the initial day of training the subjects read literary material presented on the reading machine at rates equal to those obtained on the second (motivated) pre-test. As soon as each subject grew accustomed to the reading situation, the rate of presentation of material was increased by 2.5 words per minute daily. Oral tests of reading comprehension served as checks of the student's ability to read at increasing rates and allowed for variation in the schedule of increases of reading rates. Following training, the subjects took a third equivalent form of the reading test. Differences in reading speed scores between the second and third tests were used to evaluate the effects of the training.

While some of the faster readers appeared to benefit from training through pacing, the overall results of the study indicated that no statistically significant decreases in reading rates for the trained group occurred. As in previous studies, motivation appeared to be a major factor affecting reading speeds.

This project was supported in part by a grant from the Vocational Rehabilitation Administration.

Experimental Arithmetic Program

The purpose of this project is to adapt the Educational Research and Development Curriculum for use with blind children and to evaluate its usefulness. This is a modern mathematics curriculum developed for sighted children by Dr. A. F. Schott. In content it resembles the several other modern mathematics programs now in use. Its advantage for the blind is that the curriculum employs a series of tangible aids which enable blind children to engage effectively in necessary mathematical operations in a concrete manner.

The Level One Program: Study of the Level One Program has been underway in the Kentucky, Maryland, Michigan, Virginia, and Western Pennsylvania schools since 1960. This curriculum takes elementary children (grades 1-4) successively through the steps of counting, addition, multiplication, subtraction, and division

in each of two cycles of the school year. It allows children to learn at their own best rates. Through use of an abacus called the Numberaid children are able to observe arithmetical operations in concrete terms and learn to describe these operations verbally. The method takes arithmetic out of the abstract and expresses it in behavioral terms appropriate to the level of maturation of children in the early grades of school. This is particularly important in the case of blind children in that numbers and arithmetical concepts are expressed on the Numberaid under the finger tips. Normally, after learning has occurred, the abacus is discarded. With blind children, it can be retained in a different form as an efficient computing tool. Results obtained this year replicate the findings of previous years. For braille students the following percentages scored at or above their level of grade placement on a standardized test of arithmetic computation: Grade 1 - 89%, Grade 2 - 73%, Grade 3 - 61%, and Grade 4 - 56%.

During fiscal 1965, plans call for revision of the test materials for better applicability to grade one and initiation of the development of an in-service training program for teachers of grades 1-4.

The Level Two Program: Formal study of the second level of the curriculum will begin this year. Initial adaptation of the curriculum was completed in 1963 and some modifications of both texts and materials are currently underway. The curriculum of Level Two includes such topics as fractions, geometry, linear measurement, measurement of area and volume, factoring, equations, and literal numbers. Especially designed tangible aids are used for instruction in fractions, geometry, linear measurement, and measurement of area and volume. Designed for use in sighted grades 4-6, the curriculum may fall in grades 5-7 for the blind. Evaluation of curriculum will assess the degree to which blind students can master the curriculum content.

Perception in Braille Word Recognition

A better understanding of the factors that help or hinder the recognition of braille words appears essential to improvement of reading instruction and to diagnosis of reading problems. Previous studies made by the department have identified several such factors. For example, braille word length is positively related to the amount of time necessary for word recognition. The presence of contractions in a word can sometimes help and sometimes hinder its recognition. Familiar words are recognized more readily than unfamiliar words. A major difference found among fast and slow braille readers is that fast readers recognize the individual braille characters more quickly than do slow readers. This year two additional studies of this problem were made.

Braille IV: Influence of Number of Dots and Dot Position on the Recognition Thresholds for Braille Words.

An earlier study indicated that braille characters with few dots were easier to recognize than those with several dots. This study asked whether this effect was involved also in the recognition of braille words.

Groups of 15 fast and 15 slow braille readers were required to recognize sets of braille words that differed in combinations of three characteristics. The number of dots included in the words was varied from 11-19 in five steps. Position of dots within words was varied between words with dots evenly distributed throughout the word and words with a preponderance of dots falling within the upper part of the word. Orthography was varied to include contracted and uncontracted words. A total of 45 five-character braille words was required to meet the conditions of the experiment. The times required for each subject to recognize the words were determined through use of the tachistotactometer which presented braille stimuli under conditions of controlled exposure.

It was found that the number of dots in braille words and the position of dots within words both had significant effects upon recognition times. However, the precise effects of these factors were not clear since variation in the factors combined with reading ability in a complex way. The groups of fast and slow braille readers were found to differ in intelligence, but not in ability to discriminate degrees of roughness.

Braille V: The influence of Braille Contractions upon the Recognition Thresholds for Words.

In previous studies, recognition times for contracted words were found usually to be greater than those for uncontracted words. The purpose of this study was to explore in greater detail the effects of contractions upon word recognition. Twenty braille readers were required to recognize contracted braille words when (a) the number of contractions within words was varied between one and two, (b) the type of contraction was varied between contractions containing dots in all three rows of the braille cell and contractions with dots falling only in the lower two rows, and (c) the position of contractions was varied to include contractions falling in the initial, middle, and final part of the word. In addition, the words studied varied along the dimension familiar - unfamiliar. Sixty-four braille words of five characters in length comprised the stimulus materials. The times required to recognize the words were established using the tachistotactometer.

Significantly longer recognition times were found for unfamiliar words and for those containing two contractions. The variables familiarity, number of contractions, position of contractions, and type of contractions combined in a number of complex ways to affect the recognition times of words.

Reviewers of the previous studies of perceptual factors in braille word recognition properly pointed out that since these studies dealt with words exposed in isolation, the results might not apply to word recognition in common reading situations. Normally, words occur in combination with other words which influence their ease of recognition. The next series of studies in the project will deal with recognition of words exposed in context. A pilot study of this type was completed during the summer.

This project was supported in part by a grant from the National Institutes of Health.

Reading and Listening in Learning by the Blind

While auditory communication has always had a role in education of blind children, traditionally, educators have emphasized written communications in the form of braille and large type books. Unfortunately, reading rates for braille and large type are slow. The average blind high school senior reads braille at about 90 words per minute as compared with the 250 words per minute of his sighted peer. Average reading speed for legally blind large type readers at that grade level is estimated to be about 150 words per minute. Completing an assignment takes much longer for the blind students. His slow rate of progress in reading is often held responsible for the frequent educational retardation found among the blind.

Greater utilization of auditory communication might do much to decrease the time needed to cover an assignment. Recordings made at APH normally approximate 175 words per minute and recent research has indicated that blind children can comprehend successfully auditory material presented at 275 words per minute.

The project to compare listening with reading in learning has three goals:

1. To determine the relative efficiency of listening and reading (braille and large type) as a means of learning materials from the areas of literature, history, and science.

Studies will be carried out at both elementary and high school levels and will involve both braille and large type readers as subjects. Listening will be at normal rates of speech for this phase of the project. During the previous year 12 representative passages of 2100 words were selected as materials to be studied. These materials were recorded and reproduced in braille and large type. Tests of from 63-78 multiple choice terms were constructed to measure comprehension of each passage. Actual collection of data for this project will begin this year.

2. To explore the use of accelerated oral materials where listening is found effective as a means of learning. However, the previous step in the project must be completed before this aspect can be attempted.
3. To study techniques for using auditory materials in learning by the blind.

The goal of this part of the project is to develop guidelines and techniques for the use of recorded materials in study. During the spring a pilot study was carried out at the North Carolina school to evaluate criteria for listening ability and generally to explore listening by the blind. One hundred sixteen braille readers in grades 4-12 completed the Listening Tests from the Sequential Tests of Educational Progress and a variety of information was collected describing these students. Students were interviewed concerning their listening behavior. Listening ability at all grade levels was found to be positively correlated with IQ, ratings of personal adjustment, and measures of academic achievement in most curricular areas. No differences in listening ability were found among children divided into two visual groups, i.e., those having vision of detection of hand movement or less and those having vision greater than this amount. Data of the study indicated that growth in

listening ability leveled off by the time these children reached the sixth grade. The analysis of the interview data has not been completed.

This project is supported in part by a grant from the National Institutes for Health.

Blind Children: Degree of Vision, Mode of Reading: A 1963 Replication.

In 1961, John W. Jones, of the U.S. Office of Education, published a thorough analysis of relationships between the degree of visual handicap and the mode of reading of legally blind children in the United States. This study was based upon data supplied by APH which were obtained in 1960 through the annual registration of legally blind children. This study aroused such interest that it was decided to replicate it using the data obtained in the 1963 registration. The differences found between the 1960 data and the 1963 data were as follows:

1. The total number of legally blind children registered with APH increased by 2536 during the three year period. Of these, 2072 were enrolled in local school programs and 464 were enrolled in residential school programs.
2. Between 1960 and 1963, the percentage of students listed as braille readers decreased 5% and correspondingly, the percentage of students listed as print readers increased 5%. This appeared due primarily to a dramatic increase in the proportions of residential school students with very low visual acuities who were listed as print readers.
3. In 1963, 12% more residential school students possessing object perception or better were registered as print readers.
4. The number of legally blind students classed as "ungraded" in 1963 was 1348. This was a 50% increase over the number of students so reported in 1960.
5. The accumulation of braille readers in kindergarten and grade one so evident in the 1960 data did not occur in the 1963 data. The 50% increase in the number of braille readers classed as "ungraded" suggests that this peak in the 1960 distribution for grades was partly the result of an accumulation of children of limited academic aptitude.

Improvement of Tactual Symbols for Blind Children.

Development of an adequate symbology for use in non-verbal tactual communications will be continued in a three year research project. The objectives for this project are the following:

1. To increase the number of discriminable symbols for areas, points,

and lines that can be reproduced in vacuum formed plastic.

2. To establish minimum discriminable sizes for vacuum formed point symbols.
3. To evaluate the discriminability of the symbols now used in embossed paper maps and to increase the number of discriminable symbols available for this purpose.
4. To investigate how tactual symbols for areas, points, and lines may best be combined to provide for maximum legibility.

This project is supported in part by a grant from the U.S. Office of Education.

Evaluation of the ETS Machine Scorable Answer Sheet

A problem of long standing in the use of braille tests is test scoring. Most braille tests are reproduced in disposable booklets with one or two test items to be answered on each page. This makes the task of grading tests a laborious one. Development of a universal answer sheet would not only diminish this labor, but allow braille test publishers to supply pre-marked keys for scoring at a reasonable cost.

Personnel of Educational Testing Service have developed a model for an answer sheet that not only appears to meet these requirements, but allows for machine scoring of answer sheets as well. This model answer sheet will be evaluated in order to determine how well braille readers are able to manipulate it.

Test Adaptation

Adaptation for the blind of Form X, Stanford Achievement tests, Form B, Sequential Tests of Educational Progress (STEP), and Form A, School and College Ability Tests (SCAT) will be completed in the fall of 1964. This work had been delayed in an effort to solve the answer sheet problem.

Effects of a Braille Adaptation upon the Item Statistics of a Standardized Test

As part of the adaptation of the STEP, Form B, the Science, Mathematics, and Social Studies Tests were administered to large groups of braille students. Many of the item statistics were computed for these three tests. It is planned to compare these with the item statistics developed during the construction of the original sighted version of the test in order to assess the effects of adaptation to braille on such factors as the difficulty of individual test items.

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American Printing House for the Blind

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Department of Educational Research

Annual Report - Fiscal 1965

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General

During Fiscal 1965, research in the Department has become focused more in the communications area. In part, such concentration has been stimulated by critical findings of prior research which give promise of substantial educational payoff. In part, it is the result of extended federal support for our research in communications.

Greater involvement in these areas along with attempts to continue the broadly based research program of previous years has strained greatly our personnel resources. Attempts to alleviate this strain through recruiting additional personnel trained to doctorate level have not met with success. Unless additional personnel can be obtained it appears necessary to curtail our research in certain areas.

An encouraging development during the year has been the strengthening of our long established cooperative ties with the Department of Special Education of George Peabody College. This Department has obtained four fellowships specifically earmarked for the training of research specialist personnel for the visually handicapped. As part of this program, fellows will spend an intern period at the American Printing House (APH) during which time they will be exposed to a wide variety of research experience. Not only will this program contribute to the total field, but may serve as an eventual means of providing additional personnel for our own research program.

This fiscal year has been one of extensive travel for data collection. We have been very fortunate in obtaining the generous cooperation of administrators and teachers throughout the nation. During the past year, data were collected in the city school systems of Atlanta, Denver, and Philadelphia and in the systems of Delaware and Montgomery counties in Pennsylvania. Residential schools in Georgia, Florida, Tennessee, Kentucky, Western Pennsylvania, Ohio, Michigan, Illinois, Iowa, Missouri, Arkansas, Louisiana, Texas, Oklahoma, Kansas, Maryland, and Virginia contributed greatly to the research program. Our gratitude for cooperation rendered us by personnel and students in these school systems is very great.

Progress in Specific Research and Development Programs

1. Program for Research on Problems of Verbal Communication in the Education of the Blind

Verbal communication, either written or auditory, is the principal medium for the education of all children. The major role of APH is to supply this medium in the form of braille, large type, or talking books. In spite of the great technical progress that has occurred in production of these materials, problems relating to their use remain. These problems stem largely from limitations in the effective rates of communication attained and become more critical as the educational burden increases.

Rates of verbal communication achieved by visually handicapped children invariably have been substantially inferior to those of their sighted classmates. Research findings show that sighted high school seniors read on the average about 250 words per minute (wpm). Comparable reading rates for legally blind students are about 90 wpm for braille and 105 wpm for large type. While higher rates are possible through use of recorded text materials (150-175 wpm), these are still inferior to those achieved by the sighted.

In view of the role of APH as a supplier of verbal materials, it is only logical that much of our research effort should center on this program. Precedent for research in communication was set by the heuristically valuable study of braille reading errors started by Dr. S. C. Ashcroft during his tenure as director of the Department. This early study was followed in 1958 by formulation of a plan for a multiphase attack on problems of verbal communication.

In implementation of this plan, efforts have varied widely in scope and met with varying degrees of success. Attempts to develop predictors of reading readiness for braille have culminated in successful development of the Roughness Discrimination Test. Attempts to develop training methods to increase rates for braille reading have been fruitless. The Department has been instrumental in the revival of interest in compressed speech as a means of increasing auditory word rates and it has participated with the University of Louisville in a definitive study in this area. Over the past years, a number of factors involved in the legibility

of large type books has been studied.

The program of research in verbal communication currently consists of two projects which are described below. The first project deals with perceptual factors involved in recognition of braille words and the second project concerns the relative efficiency of reading and listening as means of learning.

A. Perception in Braille Word Recognition

A better understanding of the factors that help or hinder the recognition of braille words is essential for improvement of reading instruction and development of diagnostic approaches to reading problems. In the course of this project, studies have been made of the relative legibility of braille characters and the effects on word recognition of variation of such factors as familiarity, word length, orthography, number of dots in words, dot position in words, number of contractions, and position of contractions. Previous results show that braille characters vary in legibility and that such variation is related to the number of dots in the character and to their configuration. Studies of word recognition have shown that increase in the complexity of a word along any of the above dimensions increases the difficulty of recognition. Combining these effects tends to augment the difficulty in recognizing a word. Such effects are much more severe for slow readers than for fast.

During the past year, several studies have been made which extend these findings.

a. Effects of Context upon the Recognition Thresholds for Braille Words that Vary in Length, Orthography, and Familiarity

Groups of 15 fast and 15 slow braille readers from grades 9-12 were required to recognize sets of braille words that differed in three dimensions. Words varied in length (3, 5, and 7 characters), between being familiar or unfamiliar, and between being uncontracted or contracted. Three words representing each of the 12 possible combinations of variables constituted the group of 36 words used. The times required for each subject to recognize each word were determined through use of the tachistotactometer which presented braille stimuli under conditions of controlled time of exposure. Prior to the exposure of each word, context was provided by material presented aurally to the subject. The results were compared with results of an identical study in which context was absent.

This comparison of the results of the two studies indicated that context aids in the recognition of familiar words, but interferes with the recognition of unfamiliar words. The longer the word, the greater is the effect. In addition, results of such interactions are much more severe for the slow reading group.

The effects of the interaction of familiarity and context are greater for contracted words than for uncontracted words.

b. Word Perception of Elementary Level Readers

This study duplicated the study just described except that no contextual material preceded the exposure of the stimulus words. The purpose of the study was to enable us to compare factors in word recognition for groups of elementary readers with those previously identified for groups of high school readers. The subjects used included 15 fast and 15 slow readers from grades 4-6.

Generally, the processes in word recognition were found to be similar for elementary and high school groups. Decreasing familiarity of words greatly impeded recognition for elementary readers. Elementary readers took longer to integrate information within a word than did high school readers. There was some evidence that use of frequency of occurrence of letter and word forms as a cue in word recognition had not developed for readers at the elementary level.

c. Frequency of Occurrence of Various Aspects of Braille Symbolology

In order to determine the degree to which probability learning was involved in braille word recognition, it was necessary to develop data describing the relative frequency of occurrence of various phenomena of Grade 2 Braille. These counts, which were made for us by the APH Data Processing Department, included the frequency with which dots appear in the various cell positions, the frequency of occurrence of the different configurations within the braille cell, and the frequency of occurrence of letters, signs, and contractions within the code. The basic data upon which these counts were based included 290,000 words and over 1,000,000 braille cells.

The orders of frequency of occurrence of dots in the six cell positions and of frequency of occurrence of the 63 possible different cell configurations were related to the orders of frequency of occurrence of certain types of errors found in the word recognition studies. There appeared to be a negative relationship between the frequency with which dots occurred in the six possible cell positions and the frequency with which they were erroneously omitted in recognizing individual braille characters. The order of legibility of individual braille characters was positively related to the frequency of occurrence of the characters in written material. Both the relationships indicate probability learning is involved in the development of braille reading skill.

During Fiscal 1966 work will be continued in this project through the following studies.

d. Development and Evaluation of an Alternate Method for the Study of Word Perception

In the eight studies made up to this time, the method employed has been to expose individual braille words for successively increasing intervals of time until subjects recognize them. The dependent variable in all studies has been the minimum time in which a word is recognized. Collection of such data involves the use of bulky and complex electronics equipment plus at least a weeks stay at any given research site. This method does not allow for realistic manipulation of context as an independent variable.

In our alternate method, the subject will read a story in which certain key words will be varied along defined dimensions. This behavior will be recorded on tape. The tape for each subject will then be expanded in time through use of our Tempo-Regulator. For each key word in the story, a measure of the time elapsing between the end of pronunciation of the preceding word and the end of the pronunciation of the key word will be obtained. These measures will be used as the dependent variable for study.

It is planned to compare results obtained in previous experiments when they are repeated using the alternate method. Pilot work already completed indicates time measures may be made with a high degree of reliability. Use of this method would greatly curtail the time in the field required for projects in this program.

e. Word Perception among Readers of Low Intelligence

Reading ability has consistently been found to be positively related to intelligence. Our previous research gives some hint that the detrimental effects arising from equivalent levels of low intelligence may be much more severe in development of braille reading skills than is the case for print reading skills. It is planned to replicate our basic word recognition study with subjects selected from one or more levels of intelligence starting at IQ levels of 90 and below. As a result it will be possible to compare the word recognition behavior of these groups under conditions of varying word length, familiarity, and orthography with that of the groups previously studied.

f. Effects of Training in Character Recognition upon Braille Reading Speed

In the earlier attempts to increase reading speed, the training consisted of forcing subjects to read faster by decreasing the time the reading materials were exposed. The practice materials consisted of words and phrases in one case and of continuous prose selections in another. The only individuals who appeared to benefit from such training were readers whose skill was already high. Subsequent research findings that ability to recognize individual braille characters is a dimension that differentiates fast from slow readers indicate that the practice units in the previous studies may have been too gross for most readers.

During the Fiscal Year 1966, training procedures requiring subjects to recognize braille characters under decreasing exposure

times will be devised. The effects of such training on reading speeds will be evaluated. It is tentatively planned that much of this work will be performed by the first research intern under the joint Peabody-APH training program.

All research in this project has been supported by a grant obtained from the National Institute for Neurological Diseases and Blindness.

B. Listening in Learning by the Blind

Research results obtained by APH and others have emphasized the potential of increased use of auditory communications in the education of blind children. Among our own studies were the pilot project that indicated that learning through listening was more efficient than that through reading and the cooperative study with the University of Louisville that indicated blind children could comprehend material presented aurally at 275 wpm as well as if they read it.

The project to compare listening with reading in learning has three goals.

1. To determine the relative efficiency of listening and reading (both braille and large type) as a means of learning materials from the areas of literature, social science, and science.
2. To explore the use of accelerated aural materials where listening is found effective as a means of learning.
3. To study techniques for using auditory materials in learning by the blind.

During the initial year of this project, materials to be studied were selected and reproduced. Tests of approximately 70 items each were constructed to measure comprehension of each of 12 sets of materials. A pilot study was carried out to evaluate criteria for listening ability and to relate measures of this with measures of several listener attributes.

During the present year, one additional study was completed.

a. The Relative Efficiency of Listening and Reading in Learning Literary Material

The subjects involved in this study were 384 legally blind students from grades 4-6 and grades 9-11 in both public and residential schools. Half the students were braille readers and half were large type readers. The experimental procedure required that half of each group read literary material and half listen to literary material. Practice was varied equally among the groups between reading or listening once on one and three consecutive days.

The results of the study showed that while elementary students learned equally well by either listening or reading, high school

students learned slightly more by reading. However, when results were evaluated in terms of the amount learned per unit of time spent, learning through listening was more efficient than learning through reading by 140% for elementary students and 64% for high school students. Due to a fault in the experimental procedure, the results may slightly overestimate the efficiency of listening over reading for large type readers.

For Fiscal 1966, the following studies are planned.

b. The Relative Efficiency of Listening and Reading in Learning Social Science and Science Materials

These two studies will replicate the study just described, however, materials from social science and science will be used in place of literary material.

c. Task Analysis of Studying with Recorded Materials

One goal of the project is to study techniques for using recorded materials in learning. In an initial approach to this goal, interviews will be held with high school students who characteristically use recorded texts. The purpose of the interviews will be to elicit a detailed account of how each student studies using recorded materials. These data will be analyzed and then summarized in a task description for this activity.

Research in this project has been supported by a grant received from the National Institute for Neurological Diseases and Blindness.

2. Program for Research on Problems of Non-verbal Tactual Communication

Work in this area started with a survey of map needs and an analysis of the overall problem. These identified the need for a more versatile and discriminable non-verbal tactual symbology as well as for development of less expensive and more adaptable media than those used currently.

The initial studies in the project were concerned with identifying highly discriminable symbols for points, areas, and lines. The original work involved virkotype printing, however, this medium proved both unreliable and unstable. The work was continued using vacuum formed plastic as a medium and highly discriminable sets of symbols for points, lines, and areas were identified. Further research established the minimum sized area that could be portrayed by each areal symbol.

Work continued on symbol definition during Fiscal 1965.

a. Study of the Legibility of the Point Symbols used in Maps Embossed in Paper

The discriminability of 19 point symbols commonly used in maps embossed in paper was studied. The symbols were paired on cards each with the other and with itself. These cards were then shown individually to approximately 60 braille readers in grades 4-12. The task for each subject was to judge whether the pair of symbols mounted on each card was alike or different. The data were tabulated and summarized in the form of an error or confusion matrix. Examination of the matrix revealed that students were not able to discriminate a number of unlike pairs of symbols. However, analysis of the matrix resulted in the identification of a set of 11 symbols which were highly discriminable from one another.

b. Further Research on Vacuum Formed Point Symbols

This study had the twofold purpose of increasing the number of legible vacuum formed point symbols and setting minimum size limits for these. Paradoxically, these are opposing goals since the size of a tactual stimulus limits the possible discriminable variation in its form. Accordingly, earlier studies had involved rather large symbols that tended to encompass an area up to 5/16 inch per side. Pilot study had indicated that this size could be reduced as much as 20% with no loss in legibility. Results of this research also suggested some modification in the form of the symbols.

The symbols were modified accordingly and four more symbols designed on the basis of data obtained in previous research. These 12 symbols were reproduced in sizes that represented 20% and 40% reduction over those initially studied. Symbols of each size were then paired with themselves and each other symbol on cards. The cards were shown to 60 braille readers in grades 4-12 who were required to judge whether the pair of symbols was alike or different. The results indicated that 11 of the symbols were legible at the 20% reduced size while only six symbols were legible at the 40% reduced size.

During Fiscal 1966 the following studies will be undertaken.

c. Increase in Number of Legible Symbols for Lines and Areas

Using the dimensions contributing to symbol legibility that have been developed in previous research, attempts will be made to increase the numbers of legible symbols for lines and areas. The procedures to be followed will parallel those used in the studies described in a and b above.

d. Development and Evaluation of a New Production Method and Format for Tactual Maps

Throughout the research on tactual symbols, we have been greatly assisted by the production staff of APH headed by Mr. Virgil

E. Zickel. In this phase of the project, Mr. Zickel and his group will carry the primary burden for the development work while the Department of Educational Research will undertake the evaluation.

The goal is to develop a process for vacuum forming maps using the symbology already developed in a way to permit maximum communication. As presently conceived, maps will be formed having two levels of actual relief. The first level of relief above the smooth base surface will be defined by the plane established by areal symbols extending at a uniform height above the base. In this case, the patterns of the area symbols will serve as a figure with the smooth base surface serving as a background. The second level of relief will be defined by the plane established by linear and point symbols extending at a uniform height above both the smooth base surface and the plane established by the areal symbols. In this case, the linear and point symbols would serve as figures and the area symbols will serve as background. Once the method of production has been perfected, a variety of types of maps will be produced and evaluated for legibility and amount of communication.

Work in this program during the year has been partially supported by a grant received from the U. S. Office of Education.

3. Program for Research on Educational Measurement

Work on educational measurement was started in about 1954 when the Department began actively cooperating with Dr. Samuel P. Hayes in the adaptation of Forms J-N of the Stanford Achievement Test series for publication in braille and large type. Adaptation of these tests was completed by 1959. In 1962, a program for research and development for new or improved tests in the following categories was outlined and initiated: academic achievement, scholastic aptitude, reading readiness, group intelligence, diagnostic reading, and reading speed and comprehension.

During Fiscal 1965 many of these goals were attained.

a. Academic Achievement Tests

Previous annual reports have described our adaptation of the Sequential Tests of Educational Progress, Form B, and Stanford Achievement Tests, Form X. During this year the manuals for the tests were written and both test batteries made available for use.

The publication of these tests ushered in two departures from previous practices in testing the blind. One such departure was to minimize the importance of rigid time limits for achievement tests. Since achievement tests are primarily designed to measure amount of knowledge rather than speed of performance, this step appeared a realistic one in the case of visually handicapped children. The other departure stemmed from the fact that some test items cannot be reproduced in tactual form and must be omitted. This, of course, invalidates the test norms. For these two

achievement batteries, new norms were developed for any test modified through dropping items. This was accomplished through equating procedures which resulted in norms comparable to the full length version of the test.

b. Scholastic Aptitude Tests

Previous reports have described the adaptation of Form A, of the School and College Ability Tests. The writing of the manuals for this battery was completed during the year and these tests made available for use in the schools.

c. Reading Readiness Tests

The construction and validation of the Roughness Discrimination Test has been described in earlier reports. The manual for use of this test was completed during the year and these tests will be available by the start of school in 1965.

d. Development and Evaluation of Test Answer Sheets

Most braille tests are reproduced in disposable booklets with only one to four test items to be answered on each page. This makes the grading of tests a laborious task. The development of a universal answer sheet would eliminate this labor, allow for multiple use of each test booklet and allow publishers to supply keys for test scoring at a reasonable cost.

Personnel of Educational Testing Service with our assistance have developed a format for an answer sheet that meets these requirements and allows for machine scoring of answer sheets as well. During this year, experimental use was made of the answer sheet using 125 students in grades 4-12 as subjects. After a short preliminary period of instruction, children were required to mark a series of 36 responses as directed by the experimenter. In addition, they were required to change five responses once they had been marked.

In general, performance in use of the answer sheet was encouraging. However, the margin of error (about 10%) in correctly marking responses was too great for use of these devices in actual testing. The possibility exists that a greater amount of familiarity with the device would reduce the error. This possibility will be explored during the forthcoming year.

Failure to establish the usefulness of the machine scorable answer sheet led to the development of a braille answer sheet. This answer sheet, which contains 65 response spaces, can be used with all achievement tests and academic aptitude tests currently published by APH.

The work accomplished during this year completed half the test development program previously planned. However, during the year it became apparent that without additional personnel the Department could not sustain the broad range of current activities.

In order to continue work in test development a cooperative program with personnel of George Peabody College was formulated and a joint proposal for funding the development of a group test of intelligence for the blind was made to a federal agency. This proposal was not accepted. Therefore, until additional personnel can be obtained within the Department, we have decided to substantially reduce activities in educational measurement. The only activity planned for Fiscal 1966 is adaptation of Form W of the Stanford Achievement Tests in the manner already described.

4. Program for Research in Mathematics Instruction

Interest in achievement in mathematics and its instruction date from the 1959 evaluation of the Stanford Achievement Computation Tests. This work, carried out jointly with Dr. S. C. Ashcroft, reaffirmed the characteristic low level of achievement of visually handicapped children in this area and identified many problems. One such problem, computing efficiency, led to the collaborative work with personnel of the Kentucky Rehabilitation Service on development of the Cranmer Abacus and its subsequent evaluation by the Department in 1963. Since that time over 4000 of these devices have been put into use by the blind.

Earlier research also showed great variation in achievement among equivalent grades in various schools indicating a curriculum problem. The advent of the various modern mathematics curricula emphasized the need for development in this area. An analysis of the problems encountered in teaching mathematics revealed a need, particularly in the elementary grades, for a curriculum that presented mathematics in a concrete fashion. Of the available modern mathematics curricula, the Educational Research and Development Mathematics Program authored by Dr. A. F. Schott best appeared to fill these requirements.

In 1960, an experimental evaluation of the Level One Program of this curriculum was initiated at the Kentucky, Michigan, Maryland, Virginia, and Western Pennsylvania schools. This Program involved Grades 1-4. During the course of the program, teachers were provided with special training and the necessary materials were developed for use by visually handicapped children. Evaluation of the use of this curriculum over a four year period revealed that visually handicapped children reached achievement levels comparable to or in excess of those attained by sighted children in standard programs.

The Level Two Program, for Grades 5-6, has also been adapted for the blind. However, it is possible that completion of this Program may require longer for the blind than for the sighted. While this program has not been formally evaluated, informal evaluations indicate its merit. Level Three of the curriculum has not yet been adapted, however, adaptation of this program will be undertaken when needed.

A critical requirement in adaption of the curriculum is that

1. The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that proper record-keeping is essential for the transparency and accountability of the organization. This section also outlines the various methods used to collect and analyze data, ensuring that the information is reliable and up-to-date.

2. The second part of the document focuses on the implementation of the proposed changes. It details the steps involved in the transition process, from the initial planning phase to the final execution. This section also addresses the potential challenges that may arise during the implementation and provides strategies to overcome them.

3. The third part of the document discusses the impact of the proposed changes on the organization's overall performance. It highlights the expected benefits, such as increased efficiency and cost savings, and provides a detailed analysis of the potential risks. This section also includes a timeline for the implementation of the changes and a list of the key personnel responsible for each stage of the process.

4. The fourth part of the document provides a summary of the findings and conclusions. It reiterates the importance of the proposed changes and the need for continued monitoring and evaluation. This section also includes a list of recommendations for future research and a final statement of the author's conclusions.

teachers be specifically trained in its use. This is necessary because the mathematical contents and techniques used in instruction deviate considerably from traditional mathematics curricula. While training is best accomplished through participation in formal workshops, it is not always possible for teachers, particularly replacement teachers, to attend these classes. In our last annual report, a project was outlined for the development of on-the-job training programs for this purpose. As the initial step in this project, a Level One Workshop was recorded on tape. This tape is currently available for use. By midyear it had become apparent that the scope of research within the Department must be reduced. Since teacher training was rather remote from the overall goals of APH, it was decided to discontinue research in this area.

5. Other Activities of the Department

Efforts have been made throughout the year to assist the Plant Manager and his staff in assessing the performance of the Lavender Braillewriter. To this end performance questionnaires were sent to purchasers of the first 1200 writers. These results have been analyzed and presented to the appropriate personnel. Subsequently, the Department has participated in considering the implications of the findings for future braillewriter production.

6. Papers given in Fiscal 1965

Nolan, C. Y. Research related to the education of visually handicapped children. CEC Eastern Regional Conference, Washington: December 1964.

7. Publications in Fiscal 1965

American Printing House for the Blind. Cooperative School and College Ability Tests. Supplemental directions for administering braille tests. Louisville: Author, 1965.

American Printing House for the Blind. Cooperative School and College Ability Tests. Supplemental directions for administering large type tests. Louisville: Author, 1965.

American Printing House for the Blind. Cooperative Sequential Tests of Educational Progress. Supplemental directions for administering braille tests. Louisville: Author, 1965.

American Printing House for the Blind. Cooperative Sequential Tests of Educational Progress. Supplemental directions for administering large type tests. Louisville: Author, 1965.

The first part of the report deals with the general situation of the country. It is a very interesting and informative study of the country's development. The author has done a great deal of research and has gathered a wealth of material. The report is well written and is a valuable contribution to the study of the country's development.

The second part of the report deals with the economic situation of the country. It is a very interesting and informative study of the country's economic development. The author has done a great deal of research and has gathered a wealth of material. The report is well written and is a valuable contribution to the study of the country's economic development.

The third part of the report deals with the social situation of the country. It is a very interesting and informative study of the country's social development. The author has done a great deal of research and has gathered a wealth of material. The report is well written and is a valuable contribution to the study of the country's social development.

The fourth part of the report deals with the political situation of the country. It is a very interesting and informative study of the country's political development. The author has done a great deal of research and has gathered a wealth of material. The report is well written and is a valuable contribution to the study of the country's political development.

The fifth part of the report deals with the cultural situation of the country. It is a very interesting and informative study of the country's cultural development. The author has done a great deal of research and has gathered a wealth of material. The report is well written and is a valuable contribution to the study of the country's cultural development.

- American Printing House for the Blind. Stanford Achievement Test. Forms W, X, and Y. Directions for administering braille editions - advanced battery. Louisville: Author, 1965.
- American Printing House for the Blind. Stanford Achievement Test. Forms W, X, and Y. Directions for administering braille editions - intermediate I battery. Louisville: Author, 1965.
- American Printing House for the Blind. Stanford Achievement Test. Forms W, X, and Y. Directions for administering braille editions - intermediate II battery. Louisville: Author, 1965.
- American Printing House for the Blind. Stanford Achievement Test. Forms W, X, and Y. Directions for administering braille editions - primary II battery. Louisville: Author, 1965.
- American Printing House for the Blind. Stanford Achievement Test. Forms W, X, and Y. Notes for administering large type editions. Louisville: Author, 1965.
- Nolan, C. Y. Blind children; degree of vision, mode of reading: A 1963 replication. In Inspection and Introspection of Special Education. Washington: Council for Exceptional Children, 1964.
- Nolan, C. Y., & Morris, June E. Bibliography of research on the blind, 1953-63 with 1964 supplement. Louisville: American Printing House for the Blind, 1964. (mimeo)
- Nolan, C. Y., & Morris, June E. The Japanese abacus as a computational aid for blind children. Except. Children, 1964, 31, 15-17.
- Nolan, C. Y., & Morris, June E. Roughness discrimination test manual. Louisville: American Printing House for the Blind, 1965. (mimeo)

1. The first part of the paper is devoted to a general discussion of the problem of the existence of solutions of the system of equations

which are satisfied by the functions $u_i(x, y, z)$ and $v_i(x, y, z)$ in the domain D of the space E_3 .

It is shown that the system of equations is solvable in the domain D if and only if the functions $f_i(x, y, z)$ and $g_i(x, y, z)$ satisfy certain conditions.

2. In the second part of the paper the problem of the uniqueness of the solution of the system of equations is considered.

It is shown that the solution of the system of equations is unique in the domain D if the functions $f_i(x, y, z)$ and $g_i(x, y, z)$ satisfy certain conditions.

3. In the third part of the paper the problem of the construction of the solution of the system of equations is considered.

It is shown that the solution of the system of equations can be constructed by the method of successive approximations.

4. In the fourth part of the paper the problem of the stability of the solution of the system of equations is considered.

It is shown that the solution of the system of equations is stable in the domain D if the functions $f_i(x, y, z)$ and $g_i(x, y, z)$ satisfy certain conditions.

American Printing House for the Blind

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Annual Report - Fiscal 1966

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General

Communications problems in the education of the visually handicapped continued to be the focal point of the research program during Fiscal 1966. Studies were concentrated in areas of tactile verbal communication, auditory verbal communication, and tactile non-verbal communication. A historical account of the development of the research programs in each of these areas can be found in the departmental report for Fiscal 1965.

For several years it has been apparent that the Department must expand through employment of research personnel representing a diversified array of skills or greatly reduce the breadth of its research program. During this fiscal year, possible avenues for expansion including joint relationships between APH and nearby colleges and universities have been explored. At the time of the writing of this report, no decision has been made concerning possible expansion. For this reason, the part of the Annual Report which, in the past, has described the research program for the forthcoming year is not as explicit as usual.

In last year's report the formulation of a cooperative program with the Department of Special Education of George Peabody College for training research specialist personnel in the field of the visually handicapped was announced. This program was very pleasantly inaugurated this spring when Miss Freda Henderson, who is working toward an Educational Specialist degree, spent a two-month internship in the Department. During this period, Miss Henderson participated in our research programs dealing with tactile and auditory verbal communications.

Once again department personnel were required to travel widely to obtain the participation of visually handicapped students as subjects in the various research studies. Students participating in

this year's program came from the public school systems of Louisville, Indianapolis, Pinellas County (Florida), Berkeley, Oakland, and San Francisco. Residential schools providing subjects included Alabama, Arizona, Arkansas, California, Indiana, Kentucky, Maryland, Missouri, New Mexico, Ohio, Oregon, Overbrook, Tennessee, Virginia, and Washington. The Department is extremely grateful for the cooperation given by personnel of these school systems and their students.

Progress in Specific Research and Development Programs

A. Perception in Braille Word Recognition

1. Development and Evaluation of an Alternate Method for the Study of Word Perception.

In the eight studies of factors affecting word perception made up to this time, the method employed has been to expose individual braille words for successively increasing intervals of time until subjects recognize them. The dependent variable in all these studies has been the minimum time required for word recognition. Since this method utilizes single words as stimuli, the findings resulting from its use are open to the criticism that they are biased by the unrealistic methods employed. The purpose of this study was to validate the general approach used in the previous studies.

A definitive initial study had been concerned with the effects of variations in the length, familiarity, and orthography of words upon the times required for their recognition. The 36 stimulus words employed in the initial study varied in steps of 3, 5, and 7 characters in length; in being orthographically contracted or uncontracted; and, from the point of familiarity, of having a very high or very low frequency of occurrence in children's literature. In the alternate method, these same stimulus words were embedded in the body of a short story especially written for the study and the subject read them aloud naturally as they were encountered. The oral reading behavior of each subject was recorded. As before, the 26 subjects were equally divided among groups of fast and slow readers.

The record of reading for each subject was then expanded or lengthened in time duration through use of the Tempo-Regulator. For each key word in the story a measure of time elapsing between the end of pronunciation of the preceding word and the end of the pronunciation of the stimulus word was obtained. These measures were used as the independent variable for the study.

While results of the two studies were not completely comparable, in general, the findings of the initial study were confirmed. These were that recognition times of braille words increase as words become longer, less familiar, and shift from uncontracted to contracted form. As before, these factors interacted in that shifts in one, along the directions indicated, augmented shifts in another.

2. Word Perception Among Readers of Low Intelligence

In previous studies of word perception, the IQ of subjects was found to be positively related to perceptual ability. However, in these studies all subjects fell well within the normal intellectual range. In order to investigate further the relationship of intellectual ability to word recognition skill, the basic study of the effects of word length, familiarity, and orthography was replicated using braille readers whose IQ fell within the range of 54-86. Two groups of 15 students from grades 3-5 and 7-9 served as subjects. To be included in the study, students had to demonstrate at least a moderate degree of reading comprehension. The basic data for the study were the times required to recognize braille characters and words when they were randomly presented under conditions of increasing time of exposure.

The reading rates for the subjects were very slow (about 40 wpm) and showed no improvement with increase in grade level. As compared to readers of normal intelligence, ability to recognize braille characters was quite inferior and word recognition for low IQ readers about 60% more time. Low IQ readers appeared less able to utilize peripheral cues for word recognition. Ability to recognize braille characters and words appeared to deteriorate with increase in grade level, however, this may have resulted from selective factors alone.

3. Effects of Training in Character Recognition upon Braille Reading Speed.

A major conclusion drawn from previous research on perception in braille word recognition was that the braille character was the perceptual unit in braille reading. Word recognition, then, resulted from a sequential integration of information obtained from the characters in the word as they were encountered over a temporal interval. It follows from this conclusion that improvement in ability to recognize characters should result in improved reading performance. The purpose of this study was to test this hypothesis.

In the study, control and experimental groups of 12 children, each from grades 3-6, were equated for age, sex, reading performance, and IQ. Prior to training of the experimental group, measures were obtained for both groups on silent reading speed and comprehension, oral reading speed and errors, and reading speed and errors for lists of braille literary characters. The experimental subjects were then given 18 daily individual sessions in which they were trained in character recognition. During training the subjects were informed of the level of their performance and remediation of errors was stressed. Following training measures were made similar to those obtained prior to training.

Analysis of the results revealed that the experimental group reduced errors in character recognition by 85% and mean character reading time by 30%. These gains were statistically superior to those for the control group. Experimental subjects increased their oral reading rate by 12 words per minute as compared to no increase

for the control group. These differences were also statistically significant. In addition, it was found that 58% of the experimental as opposed to 18% of the control group increased their rate of silent reading with no loss in comprehension. These latter differences were not statistically significant.

The overall results of this study tend to confirm the conclusions previously reached on the primary role of the braille character in word perception.

4. Future of the Project

The ten studies conducted under this project have been supported by a grant from the National Institute for Neurological Diseases and Blindness which will terminate at the end of 1966. Present plans call for publication of the results of the project in book form during fiscal year 1966. There are at present no plans for further research in this area.

B. Listening in Learning by the Blind

1. The Relative Efficiency of Listening and Reading in Learning Social Studies Material

Research results obtained by APH and others have emphasized the potential of increased use of auditory communications in education of blind children as a means of reducing the communications burden. The purpose of this study was to compare amounts learned through use of written and recorded media. Involved in the study were 384 legally blind students from grades 4-6 and 9-12 in both public and residential schools. Half the students were braille readers and half were large type readers. The experimental procedure required that half of each group read social studies material and half listen to social studies material. Practice was varied equally among the two groups between listening or reading once on one and three consecutive days. Subjects were tested for comprehension immediately following their last scheduled practice session.

The results showed that elementary level students, regardless of whether they read large type or braille, learned equal amounts through reading and listening. High school students of both kinds learned a small but significantly greater amount when social studies materials were read. A more realistic interpretation of the results from the standpoint of communications efficiency is apparent when the amount learned by each group is expressed in terms of the time required to learn it (reading and listening time). Under these conditions, it appears that elementary level students learn 307% more social studies per unit of time spent listening than per unit of time spent reading. For high school students, listening is 190% more efficient than reading. Relative efficiency was slightly greater for braille readers than for large type readers.

2. The Relative Efficiency of Listening and Reading in Learning Science Material.

The background and procedures for this study were identical with those for the research on social studies material just described.

The results of the study showed, that for both elementary and high school students, the learning achieved through listening and reading was equal. When amounts learned were expressed in terms of time spent to learn, it was found that listening was 237% more efficient than reading for elementary students and 220% more efficient for high school students. Relative efficiency was somewhat greater for braille readers than for large type readers.

3. Further Research During Fiscal 1967

During this period it is planned to make further studies of the relative efficiency of listening and reading using moderate amounts of compressed speech. In addition, further work will be done in describing the tasks involved in study using recorded text materials. An attempt will be made to write specifications for design of a station for such study.

C. Program for Research on Problems of Non-verbal Tactual Communication

1. Development and Evaluation of Additional Symbols for Lines and Areas for use in Vacuum Formed Plastics.

Two parallel studies were conducted for the above purposes. Earlier research had developed seven linear symbols and seven areal symbols which were legible to the extent that only 5% of braille readers in grades 4-12 confused any one for any other. For these studies six additional line symbols and four additional areal symbols were designed on the basis of criteria for symbol legibility developed from previous research. The new symbols were combined with the previously identified symbols in a random pair comparison procedure where every symbol was judged for legibility in combination with every other symbol of the same type and with itself. Two groups of 60 braille readers from grades 4-12 were required to judge pairs of each set of symbols as "alike" or "unlike".

The results indicated that four of the newly designed line symbols were legible when used in combination with the original set. Therefore, a set of 11 highly legible lines was available for use in plastic media.

For the areal symbols, the results indicated that only one new symbol was legible when used in combination with those previously identified. An interesting peripheral finding was that directionality of symbols in relation to position on the page does not become a cue for discriminability until after grade six.

2. Research Planned for Fiscal 1967

Evaluation of the legibility of 22 line symbols designed for use in embossed paper will be made during this period.

Study of techniques for combining point, area, and line symbols in vacuum formed maps will take place. The variables to be studied will include distance of separation between symbols and degrees of differentiation of symbol classes from the basic background of maps. It is hoped that procedures can be developed in this study for gathering data describing the techniques used by the blind to perceive gross two dimensional stimulus fields.

D. Program for Research on Educational Measurement

1. Academic Achievement Tests

It was planned to adapt and equate Form W of the Stanford Achievement Test to Form X during Fiscal 1966. Arrangements were made with a large public school system to administer the tests for this purpose. Results of the administration failed to meet the requirements originally agreed upon. While the data obtained did allow for equating the appropriate score distributions for their means, it did not allow for equating these distributions for variability. Therefore, development of only an interim set of norms for certain of the subtests within each battery was possible.

2. Research for Fiscal 1967

Additional data to allow for complete equating of Form W of the Stanford Achievement Test with Form X will be gathered. In addition, further investigation of the accuracy with which braille students can mark the machine scorable answer sheet developed by Educational Testing Service will be conducted.

Papers Given in Fiscal 1966

- Kederis, C. J. Braille reading in the intermediate grades. Intermediate Workshop, AAIB, Salt Lake City, 1966.
- Kederis, C. J. Research in the education of the visually impaired at APH. Florida State Department of Education, Institute for Teachers of the Visually Impaired, Daytona Beach, 1965.
- Morris, June E. Relative efficiency of reading and listening for braille and large type readers. AAIB, Salt Lake City, 1966.
- Nolan, C. Y. Perceptual factors in braille word recognition. AAIB, Salt Lake City, 1966.

Publications in Fiscal 1966

- Kederis, C. J., Siems, J. R., & Haynes, R. L. A frequency count of the symbology of English braille grade 2, American usage. International Journal for the Education of the Blind, 1965., 15, 38-46.
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- Nolan, C. Y. Blind children: degree of vision, mode of reading - a 1963 replication. New Outlook for the Blind, 1965, 59, 233-238.
- Nolan, C. Y., & Morris, June E. Development and validation of the Roughness Discrimination Test. International Journal for the Education of the Blind, 1965, 15, 1-6.

American Printing House for the Blind

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Department of Educational Research

Annual Report - Fiscal 1967

Carson Y. Nolan, Director
June E. Morris, Research Associate
Cleves J. Kederis, Research Associate
M. Gail Smith, Research Assistant

General

Research in the area of communications continued to be the central theme of departmental effort. Major activity fell in the areas of auditory verbal communication and tactile nonverbal communication. This fiscal year witnessed the conclusion of the six-year research project on perception in braille reading.

The role of the department with respect to its total relationship with the field of education of the blind is currently undergoing analysis for possible redefinition. Explorations of possible avenues for expansion of the department, particularly with respect to joint relationships between APH and nearby colleges and universities, have not yet been fruitful. Within APH, the establishment of the Instructional Materials Reference Center, with its emphasis on research and development of educational materials, has great implications for the future direction and scope of departmental activities. In view of these ambiguities, the level of research effort has been depressed. The resulting reduction in the extent and scope of the research effort will probably reach its maximum during fiscal year 1968. This will be reflected in the plans for future research described in this report.

Again this year, the efforts of the department were greatly facilitated by the excellent cooperation offered by administrators, teachers, and students representing schools throughout the United States. Participating in our research studies were the public school systems of Springfield and Macedonia, Ohio and the following residential schools: Colorado, Florida, Georgia, Illinois, Indiana, Kansas, Kentucky, Louisiana, Missouri, New York State, Oak Hill, Ohio, Overbrook, Texas, Western Pennsylvania, West Virginia, and Wisconsin.

Progress in Specific Research Programs

A. Perception in Braille Word Recognition.

As indicated above, this project terminated at the end of 1966. The results of the project will be reported in a monograph which will contain descriptions of the 10 studies completed under the project, a theory of braille reading based on the findings, a literary review, and a bibliography of research on braille. This monograph is in the process of final revision.

B. Reading and Listening in Learning by the Blind.

This year was the last year for a four-year project funded by the Public Health Service for study in this area. One major study consisting of six substudies was completed.

1. Active and Passive Listening under Conditions of Normal and Compressed Speech Rates.

Six studies employing identical designs comprised this phase of the project. Three studies used subjects from grades 4-7, and three used subjects from grades 9-12. Learning of three different subject areas (literature, social studies, and science) was tested at each grade level.

One hundred twenty students in each study were equally divided among three modes of listening: (1) continuous listening, (2) listening interrupted for 45-second periods at four evenly spaced intervals during which the subject was instructed to mentally review what he had just heard, and (3) listening interrupted for four-minute periods at four equally spaced intervals during which the subject made notes of what he had just heard, using a braillewriter provided for the purpose. In addition, students within each listening mode were equally divided into two groups; one which listened to material presented at a rate of 175 wpm and a second which listened at a rate of 225 wpm. All listening passages were selected for appropriateness for use at the grades involved. The normal playing time for each was about 13 minutes. Immediately following listening, all subjects were tested for comprehension on multiple choice tests constructed especially for this purpose.

A special feature of these studies was the technique used to assure high levels of motivation. At each research site, participants were told they had been divided into equal groups and were to participate in a "listening contest," and that members of the group achieving the highest average score would each receive a box of candy as a reward.

Generally, the findings of the studies were the following. Students who actively participated in the listening process through periodic mental review or note taking made higher comprehension scores than those who took only a passive part. A most surprising finding was that students listening at normal rates uniformly comprehended more than those listening to material which had been speeded to a moderate degree. In all previous research, comprehension at these comparative levels has been equal.

2. Future Research in Listening.

A proposal has been submitted to provide resources for four more years of research and development in this area. The next phase of the project would continue to compare learning through listening with that through reading. Emphasized in this research would be listening at faster than normal word rates and techniques for most efficient listening. As a first step toward achievement of this latter goal, a task analysis of the job of learning through listening would be made. A task analysis specifies, along a time scale, the cues which the human should perceive in the task environment, the related responses which the human should make, and the environmental conditions under which these occur. This information will be used to design study techniques. In addition, it will provide the basic information for the design of an aural study system for the visually handicapped. The system will consist of playback equipment, text-book formats, and response equipment designed and integrated around the job of learning through listening.

C. Research in Nonverbal Tactile Communication

1. The Discriminability of Lines Used in Embossed Paper Maps.

Twenty-one linear symbols used for embossed paper maps and other graphics were studied. The symbols were paired on cards, each with every other symbol and itself. Using a randomized pair comparison procedure, these cards were shown to 60 braille readers in grades 4-12. The task for each subject was to judge whether the pair of symbols mounted on each card was alike or different. Tabulation of the data in the form of a confusion matrix led to the identification of a set of 13 linear symbols which were highly discriminable.

2. Study of Techniques for Symbol Combination.

In the previous departmental report, plans for study of legibility of combinations of areal, linear, and point symbols for use in vacuum-formed maps were mentioned. The variables to be studied included distance of symbol separation and degrees of vertical differentiation of classes of symbols from the basic background surface of the map.

Due to technical difficulties in production of experimental materials, this phase of the project was delayed and will be undertaken during fiscal 1968.

3. Exploratory Study of the Behavior of Blind Students in Map Reading.

A pilot study of the behavior of students reading maps was made through analysis of slow motion picture records of this behavior. Subjects were nine braille readers from the elementary grades and nine from the high school grades. Four-minute samples were filmed of students' behavior while trying to follow a path on a map and while trying to identify identically coded areas. While attempts to quantify the data left much to be desired, results indicated that students used molecular approaches in reading maps to an extent that seriously impaired their working ability and that ability to read maps did not increase between the elementary grades and high school.

4. Research for Fiscal 1968.

The photographic data described above, together with whatever additional photographic records are required, will be analyzed to reveal characteristic modes of behavior, types of errors made and to identify patterns of inadequate behavior. This information will serve as a base upon which to design a pilot training program in map reading. The pilot training program will be evaluated by training students and comparing their time and error scores on map tasks with their pretraining scores or those of a control group. The number of subjects involved would be 20-30 tactual readers at the elementary and secondary levels.

D. Research in Educational Measurement.

1. Data were collected to enable APH to equate Form W of the Stanford Achievement Tests to Form X. For this purpose, 500 students in grades 5-6 in the Springfield, Ohio, public schools were given both forms of the Intermediate Battery and 800 students in grades 7-9 of the Macedonia, Ohio, public schools were given both forms of the Advanced Battery. Analysis of these data is about completed and revised norms for W should be available late this fall.

2. Evaluation of a Machine-Scorable Answer Sheet

Further tests were made of the machine-scorable answer sheets for use with braille tests which were developed by personnel of Educational Testing Service. In previous trial use of these materials, students had exhibited a 10% error in accuracy in marking these forms. However, it was believed that lack of familiarity with the device may have been responsible for this high rate of error.

During this year small groups of elementary students received three days training in marking the sheets under three different sets of conditions: (a) close supervision on each of three days with immediate correction of errors as they occurred, (b) close supervision on each of three days with knowledge of results of each day's performance, and (c) close supervision on each of three days with a tangible reward (candy) being offered to each student who improved in performance.

Error rates under all these conditions were higher than desirable. Individual students showed great variability in accuracy.

E. A 1966 Reappraisal of the Relationship between Visual Acuity and Mode of Reading for Blind Children.

In 1963, the department replicated the analysis of relationships between degree of visual handicap and mode of reading of legally blind children originally made by John W. Jones of the U. S. Office of Education in 1961. These studies, based on data obtained through the annual registration of blind children with APH, aroused such interest that it was decided to continue replications at three year intervals. A summary of the 1966 finding is as follows.

1. The total number of legally blind students registered with the American Printing House in 1966 was 19,007. This represented an increase of 1,897 over the number enrolled in 1963.

2. Of this total, 10,835 were enrolled in local day school programs, 6,886 were enrolled in residential schools for the blind, 663 enrolled in educational programs coordinated by state commissions for the blind, and 268 were enrolled in residential programs for the multiply handicapped (principally mentally retarded and deaf-blind).

3. It appeared that during this period local school enrollments increased about 15% while those of residential schools remained static. However, because of changes in the reporting system, these data are only approximations.

4. Forty-six percent of legally blind children was reported as reading braille in 1966 as compared to 53% in 1963. Thirty-six percent of the group was reported reading large type in 1966 as compared to 43% in 1963. Eleven percent of the group was reported as utilizing regular ink print materials to some extent. Again, the clarity of the data are obscured by changes in the reporting system.

5. There appeared to be a consistent trend in all school systems toward greater use of residual vision. School systems appear to be characterized by emphasis on a particular type of medium which for residential schools is braille, for local schools is large type, and for programs coordinated by commissions is regular ink print. These emphases do not necessarily reflect the visual attributes of the population served.

6. The number of legally blind students classified as ungraded in 1966 was 2,324. This represents an increase of almost 50% over the number so reported in 1963 and an increase of 100% in the number so reported in 1960.

F. Cooperation with the APH Instructional Materials Reference Center.

Department personnel have participated in the activities of the new APH-IMRC since its inception. The Director participated in the initial planning for the Center, in three initial meetings for development of the nationwide Special Education Instructional Materials Center Network, and in the drafting of an overall plan for the evaluation of materials by the IMRC.

All personnel in the department have participated in the collection of descriptions of teacher developed materials as an activity incidental to research oriented visits to schools.

Papers given in Fiscal 1967

Nolan, C. Y. Research in Education. Read at Research Consultations Concerning Needed Research in the Behavioral Sciences and the Humanities with Reference to Work with the Blind. Pennsylvania State University, 9-12 April 1967.

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Nolan, C. Y. Audio materials for the blind. Audiovisual Instruction, 1966, 11, 724-26.

Nolan, C. Y. Reading and listening in learning by the blind. (Progress report, U. S. Public Health Service Grant No. NB-04870-04.) Louisville: American Printing House for the Blind, 1966.

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Nolan, C. Y. Listening and reading in learning. In E. Foulke (Ed.) Proceedings of the Louisville conference on time compressed speech. Louisville: Center for Rate Controlled Recordings, University of Louisville, 1967. Pp. 67-68.

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Department of Educational Research

Annual Report - Fiscal 1968

Carson Y. Nolan, Director

June E. Morris, Research Associate

Frank L. Franks, Research Intern (part-time)

General

The theme of our research program has continued to be communication with emphasis shifting from the behavioral areas to materials development.

The role of the department has continued to be flexible and to shift with research and development requirements as they arise within the American Printing House (APH). During the past year, the director has spent almost half of his time in assisting in the growing research and development effort occurring within the framework of our Instructional Materials Reference Center. Our research project on listening is being conducted in collaboration with Mr. Scheurich and personnel of the Recording Department. In addition, research assistance has been rendered to other departments of APH.

Our informal relationship with Peabody College has continued to flourish. Two Peabody graduate students in special education participated as research interns in our program during the year. These were Miss Hilda Caton and Mr. Frank Franks. Mr. Franks will stay on during Fiscal 1969 and will be joined by Mrs. Nancy Steele. In addition to their material contributions to our research, our interns have provided much intellectual stimulation. It is hoped that this program continues.

The APH Board of Trustees has provided resources for broadening our research program. Of particular interest is initiation of a long range program of basic research in tactile perception as it is relevant to education. Search for personnel for this program is currently underway.

Progress in Specific Research Activities

A. Reading and Listening in Learning by the Blind.

At midyear, we received substantial support from the U. S. Office of Education for a four-year program of research and development in this area.

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Not only did this award provide for further comparative studies of listening and reading in learning, but also provided support for the development of a comprehensive system for study using recorded media. Work on the project undertaken during this fiscal year included the following:

1. Task Analysis of Study through Listening.

In order to design an aural study system, a thorough understanding of the tasks involved in study through listening is necessary. To gain this knowledge, an analysis was made of the processes involved in studying from recorded textbooks. The books used were three previously recorded at APH in the Talking Book program and the equipment used was an APH reproducer. The analysis resulted in identification of 15 distinct tasks involved in study from records. The steps necessary to complete each task were described in detail by identifying each necessary response, sequentially, along with the cue initiating it. This information was then used to help generate a tentative set of specifications for the design of play back equipment to be used in a study system.

2. Design of Play Back Equipment.

Specifications for this equipment include those for physical size and for operation. From the physical standpoint, the equipment should be portable - small and lightweight. In terms of operating characteristics, it should have instantaneous stop-start, forward-backward movement, variable speed, remote controls for stop-start and forward-reverse, detent tone-arm positioning, and multitrack operation. During this year an extensive study of electronic and other components for use in the play back equipment has been undertaken. A variety of AC and DC motors, speakers, tone arms, miniturized amplifiers, controls, and other components have been found or developed and evaluated. This work, of course, is being conducted for us by the Recording Department.

3. Application of Stereophonic Recording Techniques to Recording Indexing.

Place finding with recorded material is a task involving many difficulties. Analysis of this task indicates that supplying indexing data in a readily accessible parallel recording may help solve this problem. Application of stereophonic recording techniques where two tracks are recorded in one groove of the disc that can be played independently have been previously explored for this purpose. Preliminary steps for further research and development in this area were completed during the year. Under our OE grant, the APH Recording Department obtained a Westrex 3-D Stereodisc Transfer Recording Channel and an Additional Scully Automatic Disc Recording Lathe which have now been installed and calibrated.

Research and development activities planned during Fiscal 1969 include the following.

1. Completion of Development of Play Back Equipment.

During this year a prototype of the record player will be completed by the Recording Department according to the specifications listed above.

User tests of this device will be initiated and the study job reanalysed on the basis of these tests.

2. Definitions of Formats for Materials To Be Used in the Aural Study System.

Textbook analyses and consumer surveys will be used to identify the elements important in textbook format and to determine the form and sequence for their utilization in the aural study system. This work, initiated in July, is already well underway. During the summer, 19 blind students at the University of Texas participated in an intensive consumer survey. While the data obtained have not been completely analysed, it appears that combinations of recorded and printed materials are the most desirable for use in the system.

3. Comparison of Listening and Reading as A Means of Learning by Low IQ Blind Students.

Earlier studies in the project have pointed out the greater efficiency of listening as a means of ~~learning~~ some subjects. Research on the braille reading behavior of students with IQs below 85 has pointed up the very low levels of reading proficiency that most of these students attain. Consequently, it appears that for this group, the relative efficiency of listening over reading as a means of learning could be much greater than for students of normal and above normal mental ability. This possibility will be experimentally tested during this year.

4. Further Verification of the Greater Efficiency of Listening over Reading as a Means of Learning.

Earlier studies comparing listening and reading for learning by blind students have shown that absolute learning through listening once is equal to or slightly inferior to that for reading once. The greater efficiency for listening stems from the fact that it usually requires a great deal less time than for reading. This is only one way to estimate relative efficiency. A second way is to permit students to read or listen for equivalent amounts of time. In view of the relative word rates for listening and reading, this implies that students will listen two or more times to material while it is being read only once. Consequently, learning for listening should be greater when the same amount of time is spent in reading and listening. An experiment will be conducted to test this hypothesis.

5. Motivation and the Comprehension of Compressed Speech.

Almost all previous research on compressed speech has shown that speech presented at rates as high as 275 words per minute (wpm) could be comprehended as well as speech presented at normal rates. Recent research by APH, in which motivation of subjects was emphasized, showed regular speed rates to be superior consistently to compressed rates for comprehension. These results raise the question that previous findings may be in error because of neglect in control of the motivational variable. Therefore, study of relative comprehension for speech presented at regular and compressed rates under conditions where motivation is controlled is a project for this year.

B. Research in Braille Reading.

A monograph describing the results of our long term research project on perception in braille word recognition has been completed and is currently in the hands of the publishers. One important outcome of this was the development of a theory of perception in braille reading. This theory holds that braille word recognition, unlike its counterpoint in print reading, is a sequential integrative process in which word recognition is the result of accumulation of pieces of information over a temporal interval. The perceptual unit in braille reading is not the whole word shape, but the braille character. Skilled braille reading appears to be based on a probabilistic model of the braille reading environment. The complexity of the model developed is directly related to the mental ability of the reader. A number of perceptual cues are used to identify correctly words before all their individual characters are sensed. Among these are expectancies for the relative frequency of letters in print, experience with the relative probabilities for letters following one another, experience with the occurrence of sets of letters, experience with the grammatical structure of the language, and cues stemming from preceding context. This theory demands a decoding approach to teaching reading which is directly in contrast to the whole word and/or whole sentence approach to teaching braille reading that has been adopted by about two-thirds of the teachers of blind children in the United States, today.

During Fiscal 1969 it is planned to explore approaches to implementing our theory through design and trial use of special teaching materials and special teaching techniques.

C. Non-verbal Tactile Communication.

1. Combination of Tactile Symbols.

In our previous research, legible symbols for points, lines, and areas have been identified and studied. During Fiscal 1968, methods for combining these symbols in map form were investigated. Sets of the three symbols were combined in six pseudo-maps that varied along two dimensions - horizontal distance between symbols and vertical distance between symbols. Horizontal distance between symbols was varied through two dimensions, .090 and .150 inches. Vertical distance was varied through three conditions. In the first, the top surface of all symbols was the same distance above the background. For the second, the top surfaces of point and line symbols were higher than of that for areas. In the third, the top surface for point symbols exceeded that for lines which exceeded that for areas.

One hundred twenty-six braille readers in grades 4-12 were required to find areas and points and to follow lines under conditions where time and error records were accumulated. While for identification of areas there were no differences among conditions, identification of points and following of lines were superior under conditions of maximum symbol separation and maximum differentiations among symbol height.

2. Research for Fiscal 1969.

In last years report, plans for study of behavioral problems in map

reading were described. The results of the trial use of maps described above showed that most of the behavioral problems previously defined disappeared under conditions of maximum symbol differentiations and that the remaining problems in map reading appear to be in the conceptual domain. During the year, an exploratory study of conceptual problems in map reading will be made through requiring blind students in grades 4-12 to verbally define concepts related to map reading and to express such concepts operationally wherever possible. This study should provide directions for research and development on problems of map reading.

D. Research Reference Service Activities.

During Fiscal 1968 three major bibliographies were accumulated or revised. These include our Bibliography on Research on the Visually Handicapped, Bibliography on Tests and Testing of the Blind, and Bibliography of Research on Braille. Accumulation and dissemination of such bibliographies has been a service rendered to the field by the department for a number of years. This coming year, it is planned to thoroughly analyse and evaluate the activities of the department in this area. The emerging services of the International Reference Information Service of the American Foundation for the Blind and the Educational Resources Information Center of the U. S. Office of Education overlap considerably with our activities. Consequently, we plan to evaluate our continued involvement in this type service.

Papers Given During Fiscal 1968

Nolan, C. Y. Listening in the development of the blind child. AAIB Regional Conference, Harrisburg, Pennsylvania, November, 1967.

Nolan, C. Y. Developments in the world of braille. State meeting, American Association of Workers for the Blind, Raleigh, North Carolina, July, 1967.

Nolan, C. Y. A 1968 progress report on listening research at APH. American Association of Instructors for the Blind, Toronto, 1968.

Publications During Fiscal 1968

Kederis, C. J., Nolan, C. Y., & Morris, J. E. Bibliography of research on braille, 1968. Louisville, Ky.: American Printing House for the Blind, 1968.

Morris, J. E., & Nolan, C. Y. Bibliography of tests and testing of the blind. Louisville, Ky.: American Printing House for the Blind, 1967.

Nolan, C. Y., & Morris, J. E. Bibliography of research on the visually handicapped, 1953-1967. Louisville, Ky.: American Printing House for the Blind, 1967.

Nolan, C. Y. A 1966 reappraisal of the relationship between visual acuity and mode of reading for blind children. New Outlook for the Blind, 1967, 61, 255-261.

The first part of the report deals with the general situation of the country. It is a very interesting and informative study of the country's development. The author has done a great deal of research and has gathered a wealth of material. The report is well written and is a valuable contribution to the study of the country's development.

The second part of the report deals with the economic situation of the country. It is a very interesting and informative study of the country's economic development. The author has done a great deal of research and has gathered a wealth of material. The report is well written and is a valuable contribution to the study of the country's economic development.

The third part of the report deals with the social situation of the country. It is a very interesting and informative study of the country's social development. The author has done a great deal of research and has gathered a wealth of material. The report is well written and is a valuable contribution to the study of the country's social development.

The fourth part of the report deals with the political situation of the country. It is a very interesting and informative study of the country's political development. The author has done a great deal of research and has gathered a wealth of material. The report is well written and is a valuable contribution to the study of the country's political development.

The fifth part of the report deals with the future of the country. It is a very interesting and informative study of the country's future. The author has done a great deal of research and has gathered a wealth of material. The report is well written and is a valuable contribution to the study of the country's future.

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Department of Educational Research

Annual Report--Fiscal 1969

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General

Research in the Department this year has focused solely on development of the aural study system for the blind. This work is being carried out in close cooperation with the Recording Department of the American Printing House.

The internship program with George Peabody College has continued to function well. Next year we will have two new interns from Peabody, Roy Brothers and Dick Umsted. Interest in this program is growing among other universities with training programs for teachers of the blind and we expect interns from other sources in coming years.

Progress in Specific Research Activities

A. Design of an Aural Study System for the Blind.

We are now in the second year of this project which is supported by a grant from the U. S. Office of Education. The purpose of the project is to study the process of learning through listening and to develop a system specifically for this purpose. The system will include especially designed playback equipment, textbook formats, and study techniques. During the year research on the project took several directions.

1. Comparison of Listening and Reading as a means of Learning by Low IQ Blind Students.

This study was designed to compare the relative comprehension of low IQ students for materials presented in braille and recorded form. The subjects were 80 students from five residential schools whose IQ's were 85 or less, who ranged in age from 9-20 years, and who had received braille instruction for at least three years. On the basis of a reading test, these students were divided into four groups of readers who possessed high reading rates--high comprehension, high rates--low comprehension, low rates--high comprehension, and low rates--low comprehension. The four groups were randomly divided so that half read

materials in braille and half listened to the same materials. All subjects read or listened to two passages at the second and six grade reading level. Students read or listened to the materials only once and were tested for comprehension by a multiple-choice braille test immediately after. The general outcome of this study was that, for students whose reading comprehension was high, reading was the superior medium. For students whose reading comprehension was low, listening was the superior medium.

This study was executed by Nancy W. Steele, one of our research interns, and served as her doctoral dissertation at George Peabody College for Teachers.

2. Motivation and the Comprehension of Compressed Speech.

Two years ago, we reported research results which indicated that, under conditions of high motivation, comprehension for auditory material presented at normal rates was significantly superior to that presented under even low levels of speech compression. This was contrary to most previous research findings. This year we attempted confirmation of these results.

Two groups of 108 students from grades 4-7 and 120 students from grades 8-12 listened to literary stories appropriate for their grades. Of the total group, one-third listened to a recording at 175 words per minute (wpm), one-third at 225 wpm, and one-third at 275 wpm. Half the subjects listened under motivated conditions where each had a chance to win two prizes for superior performance. Half the subjects listened under conditions where no prizes for superior performance were offered. The major result of the study was that levels of motivation, at least as determined by the procedures of this study, had no effect on the relative comprehension for auditory materials presented at regular and compressed rates.

3. Growth of Learning with Repeated Continuous Listening.

From our consumer interviews we learned that users of recorded texts who took notes seldom listened to their texts more than once. They felt that review of these notes was sufficient for further study. This aroused curiosity about the usefulness of repeated listening and the curve for learning resulting when students listen to material for two or three consecutive presentations. Study of this problem was initiated this year.

Two duplicate experiments required learning literary and science materials through listening. Participating were students from grades 9-12 and 4-6. Equal groups of braille and large type readers were included. The primary factor studied was the amount students learned when they listened once and when they listened to two or three consecutive presentations. Data collection was completed for the study of the literary material and high school science. Results of the analysis of the data were revealing.

For high school students, repeated listening resulted in significantly increasing amounts of learning. Increases in learning appeared greater for literary materials than for science. Braille readers learned significantly more through repeated listening than did large type readers when science materials were studied. However, for both types of material, the rates of increase in learning with repeated listening were greater for braille readers.

Such was not the case for elementary students who listened to literary material. Effects of repeated listening varied from grade to grade and between the two types of readers. For fourth grade and for sixth grade braille readers, repeated exposure diminished learning. Some evidence of improvement for listening twice was apparent at the fifth grade and for sixth grade large type readers; however, listening a third time either diminished performance or failed to improve it over that for listening twice.

Consequently, while it appears that high school students derive considerable benefit from listening to material two or three times running, such is not the case for elementary level students.

4. The Relative Efficiency of Learning through Reading and Listening When Study Time is Held Constant.

In the departmental annual reports for fiscal 1965 and 1966, we reported research results showing that for literature and science materials, learning through listening was more efficient than that achieved through braille or large type reading. Listening efficiency was from 183-320% greater when amounts of learning per unit of time spent was the criterion. Combining the results of this research with those reported in item 3 above enables us to compare efficiency of learning through listening and reading when study time was held approximately constant.

For high school students, the time for reading literary and science materials once (24 minutes) was approximately equal to the time required to listen to these materials twice. For braille readers listening twice produced 10% more learning for literary material and 25% more learning for science material. For large type readers, listening twice produced the same amount of learning as reading either of these materials once. At the elementary level, listening several times produced no more learning than reading literary materials once. Consequently, when study time is held constant, listening is more efficient than reading for only those high school students who read braille.

5. Learning through Listening When Practice Is Massed and Distributed.

In our 1965 and 1966 listening research, learning for literature and science through listening and reading was compared when elementary and high school students listened to materials for one day and on three consecutive days. Combining these results with those of this year's research (see 3 above) allowed us to compare learning through listening when students listened consecutively three times on one day with that achieved when they listened three times on consecutive days. Findings from the field of learning would lead to the prediction that listening practice distributed over a three day period would result in most learning.

This is the case for elementary level children. Listening once on each of three days yields about 33% greater learning than continuous listening. However, such is not the case for high school students. Listening consecutively three times on one day produces 12% more learning than listening distributed over three days.

6. Recorded Textbook Formats and Aural Study Methods: A Consumer Survey.

Eighteen visually handicapped students at the University of Texas who were experienced users of auditory textbooks participated in each phase of this study.

Textbook Format: Three high school textbooks from the fields of literature, social studies, and science were analysed to identify their constituent parts. Lists of the 14 parts identified, along with a definition of each were reproduced in braille and large type. The lists were distributed to the subjects who were required to submit a written report giving a judgement of whether each book part would be more useful in written or recorded form and discussing their reasons for each judgement. The experimenters reviewed each report and explored any ambiguous points with each subject in an interview.

Eighty-three percent of the students preferred recorded texts with the exception of texts in mathematics, physical science, and certain languages which were more easily understood in written forms. With respect to parts of books, recorded forms were preferred for prefaces and/or forewords, acknowledgements, introductions, footnotes, and suggested activities while tables of contents, graphics, study questions, references, glossaries, and indices were preferred in written form.

Aural Study Methods: All students were interviewed in depth on 19 questions related to study. Scheduling, understanding graphics, drowsiness, note-taking, place finding, and indexing were identified as critical areas in study through listening and methods for overcoming problems in these areas were suggested.

7. Development of Playback Equipment and Recording Techniques.

The initial system designed is to be a disc system since APH possesses greatest capability in this area of recording. All design research is being carried out in the Recording Department of APH.

Early in the year, a mock-up of playback equipment was built with the following special features: (1) forward and backward turntable action, (2) instantaneous stop-start action, (3) a scanning capability (playing speed of 8 rpm and a search speed of 66-2/3 rpm), (4) a pickup arm having a retractable pickup cartridge incorporating a mechanism for positively identifying the record edge and featuring stylus pressure light enough to prevent record damage through mishandling of the pickup arm, and (5) a variable speed control which works by altering the AC line frequency which, in turn, affects the speed of the frequency sensitive turntable motor. Much activity during this year has centered on finding standard commercial components that meet the requirements of the system. More recently, the development of the system has been advanced through design of a foot control for remote operation of the four modes--stop, play, fast reverse, and fast forward.

The problem of record indexing has been a major concern. Adaptation of stereophonic recording techniques to present text material on one track in a groove and index information on the parallel track is still being explored. To date, we have not been able to achieve the degree of separation desired between sound signals emanating from the parallel tracks. An alternate system utilizing movement of the pickup arm is currently being explored. In this system, photoelectric cells in the tone arm sense very narrow bands on the record which are identified through a sound signal.

Research and Development Activities Planned for Fiscal Year 1970

A. Design of an Aural Study System for the Blind.

1. Completion of Design of Playback Equipment for the Aural Study System.

During the year design of the player will be completed and several prototypes built for testing.

2. Design of an Experimental Recorded Text.

An experimental recorded textbook for use in the Aural Study System will be designed and produced this year. Design of the book will be based on data generated during the earlier task analysis of study through listening as well as the consumer studies previously made. Especial attention will be given the indexing problem.

3. Description of Techniques of Aural Study.

Descriptions of techniques for aural study using the system will be drafted during this year. These techniques will be based on data derived from the task analysis of study, consumer surveys, and research on learning.

4. Pilot Evaluation of the Aural Studies System.

Once the three tasks described above are complete a pilot evaluation of the system will be made. This evaluation will consist of two stages, (1) evaluation by a panel of expert consultants and (2) evaluation through user tests on a small group of subjects (approximately five). Data from these evaluations will be used to modify the system where necessary.

5. Effects of Message Length and Frame of Reference on Comprehension of Auditory Material.

Previous research by APH and others demonstrates that comprehension for auditory material is affected by the length of material presented and the expectations of the listener concerning what is to be heard. Study of these factors will be the subject of a doctoral dissertation by Roy Brothers, one of our research interns from Peabody.

High school students will be required to listen to a 24 minute social studies selection. Equal groups will listen when the material is presented in message units of 2, 3, 4, and 6 minutes in length. One half of the subjects will hear a summary of what is to come prior to listening which will provide a frame of reference for listening. The other half will be denied this information. The effects of both factors on students of above average and below average levels of mental ability will be considered.

B. Relationship between Visual Acuity and Reading Medium.

In 1963 and 1966, we replicated John W. Jones' original analysis of the relationships between visual acuity, grade level, type of educational program, and reading medium. This year we plan a similar analysis for the APH quota registration data for 1969.

C. A Comparison of the Relative Legibility of Raised and Incised Figures.

A problem of long standing that impairs progress in map design is that we know very little about tactile perception of gross stimulus patterns. APH has long had an interest in research in this area, but lack of personnel has prevented its pursuit.

This year we plan a small step in this direction through a pilot study of the comparative legibility of raised and incised figures. In map terms, the question is whether a river can be better presented by a trough cut in the surface of the map or by a raised line.

To study this question we have taken and modified 15 items from Test 3 or the Nonverbal Battery of the Lorge-Thorndike Intelligence Tests and

reproduced them double size in raised and incised line form. All items require the subject to examine a stimulus figure and then find one like it from among five response figures on the same card. Groups of braille readers from grades 4, 6, 8, 10 and 12 will be required to complete the 15 items in both incised and raised form. Response times and errors will serve as criteria for comparing the two ways of presenting the same figures.

Contacts with Educational Programs

As usual many educational programs contributed to our studies and our appreciation for their contribution is great. Included among these are the following residential schools: Arkansas, Georgia, Illinois, Indiana, Kansas, Kentucky, Maryland, Missouri, Nebraska, Ohio, Overbrook, Tennessee, Texas, Virginia, Western Pennsylvania, West Virginia, and Wisconsin. Public school systems cooperating were: Philadelphia, Atlanta, Cleveland, Columbus, and the following California schools--Azusa, Berkeley, Castro Valley, Garden Grove, Long Beach, Mt. Diablo, Pasadena, San Bernardino, San Diego, San Francisco, and Walnut Creek.

During the year, personnel from the Department reported on our research to groups at George Peabody College for Teachers, Northern Illinois University, University of Cincinnati, University of Virginia, Michigan State University, Stanford University, and the meeting of the International Reading Association.

Publications during Fiscal 1969

- Morris, J. E., & Nolan, C. Y. Recorded textbook formats and aural study methods--a summary of user opinions. Unpublished report, American Printing House for the Blind, 1968.
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- Nolan, C. Y., & Ashcroft, S. C. The visually handicapped. Review of Educational Research, 1969, 39(1), 52-70.
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- Nolan, C. Y., & Morris, J. E. Research on the partially sighted. Louisville, Ky.: American Printing House for the Blind, 1969. (Bibliography)
- Steele, N. W. Learning by blind children of low ability: The relative effectiveness of reading and listening. Doctoral dissertation, George Peabody College for Teachers, 1969.

